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VOLUME XV

The Book of Knowledge

The Children's Encyclopedia

THAT LEADS TO LOVE OF LEARNING

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No 363

With an Introduction by

ALEXANDER J. STODDARD, Ed.D., L.H.D., LL.D.

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This is a guide to the principal contents of this volume. It is not possible to give all of the questions in the Department of Wonder, but the pages are given where such sections begin. The big Index in Volume 20 is a guide to your whole set. There you will find every subject that is in The Book of Knowledge.

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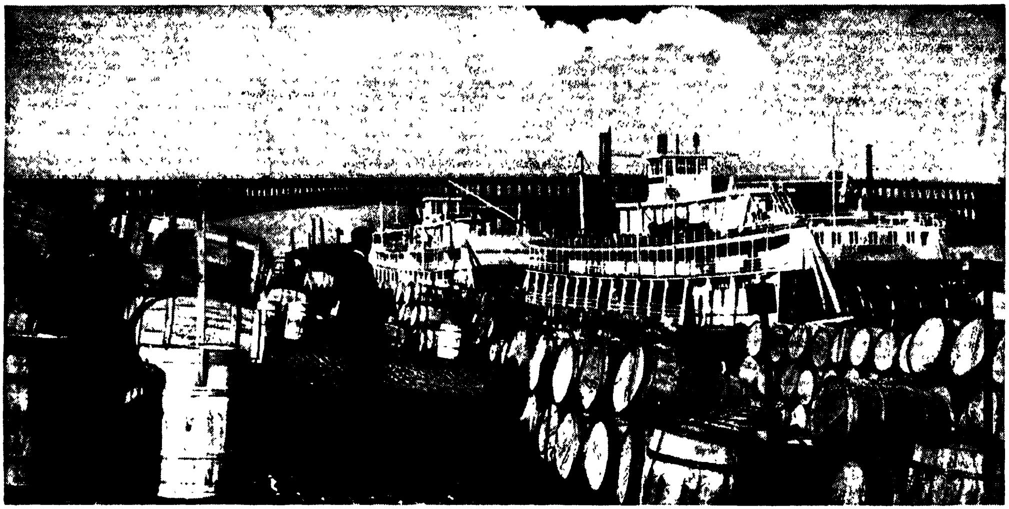


Courtesy, St. Louis Chamber of Commerce; Ewing Galloway, N. Y.

The old river front at St. Louis, looking toward the Eads Bridge. Here river boats dock to load or unload cargo.

THE NORTH CENTRAL STATES

PART I

THE North Central states are: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska and Kansas. Although these states include only one-fourth of the area of the United States, they support nearly one-third of the population. Nine of the twenty-five largest cities of the United States are in this group of states. They include Chicago, the second largest American city, and St. Louis, the largest city of the Mississippi Basin.

This region produces nearly one-half of all the farm crops, two-thirds of the wheat crop, two-thirds of the corn crop, three-fourths of the oat crop, and three-fourths of the barley crop of the United States. Many hogs and cattle are raised and fattened for the market. Apples, peaches and grapes are important fruits.

More than four-fifths of the iron ore of the United States comes from the ore lands at the head of Lake Superior. Illinois ranks third among the states in the production of soft, or bituminous, coal. Michigan leads in the production of salt and is an important copper-mining state. Missouri is the chief lead-producing state and Kansas is third in production of zinc.

The forests near the Great Lakes still yield large quantities of lumber, and the paper industry is important in Wisconsin. From the forests of southern Missouri come railroad ties, mine props, staves for barrels and hickory handles.

Under normal peacetime conditions, these states turn out, by value, four-fifths of the farm implements, three-fourths of the automobiles and two-fifths of the manufactured products of the United States. The region has about two-fifths of the railroad mileage of the country. In addition, hundreds of boats and barges carry goods on the Great Lakes and the Mississippi River system.

The people of this region have a right to be proud of what they have accomplished. In 1840 the entire region had only a few hundred thousand white people and Indians. Chicago was only a village. In 1940 more than 40,000,000 people made their living from the forests, mines, farms and factories of the region. We shall talk about what man has done and what Nature has done to make possible this remarkable story of human progress.

The earlier settlers of this region came chiefly from the older settlements of the northern and southern Atlantic seaboard, and even today experts on regional speech can trace the influence of New England and the South in the typical speech of this region, especially in the rural districts of Ohio, Indiana, Illinois and Missouri.

Between the North Central states and the Atlantic coast lies the long chain of the Appalachian Highlands. About the time of the American Revolution white people began moving into the interior of the continent through passes in the mountains. Some of these passes through the highlands led to the Ohio, the Cumberland and the Tennessee rivers. Many of these people settled in Kentucky and Tennessee. Others, following the streams, went down the Ohio River to what are now the states of Illinois and Indiana, and spread northward toward the Great Lakes.

The farmers of New England, with poor soils and hilly, rocky land, had to work hard to make a living. They heard of the rich, smooth land beyond the Appalachian Highlands, and many of them began to go to the West. Then they gradually moved southward from the region bordering on Lake Erie and Lake Michigan. Thus the Yankees spreading southward reached and mingled with the Southern people who were spreading northward at the same time into the central part of the state of Illinois.

Courtesy, Topeka Chamber of Commerce
Statue of Pioneer Mother at State House in Kansas.

Not all of the people now living in this region are descended from the first settlers. People from other parts of the United States have moved into this region, and before the middle of the nineteenth century newer immigrants from various European countries began to come. Now people from almost every nation in the world live in this section.

Before World War II the proportion of foreign-born people living in the North Central region was about 10.5 per cent—almost the same as for the United States as a whole. The proportion of the native-born of foreign parents was 16 per cent, as against 13.8 per cent for the nation; while the native white of native parents was 60.8 per cent, as against 57.1 per cent of the nation. The Negro population varied in the different states from 387,446 in Illinois to 201 in North Dakota. The largest number of Negroes is to be found in the big cities such as Chicago and Detroit. Of the foreign-born people, the largest number came from Germany, Poland and Sweden, but there were also many from Czechoslovakia, Norway, Holland and Denmark.

During the war period there was a tremendous shifting of the civilian population throughout the United States, especially of people moving to centers of war industry. Some of this change was temporary, but many of those who moved will very likely stay in the sections that they have moved to. This great shift in population caused some states to lose population and others to gain. All of the North Central states shared in this war movement of people.

When the early fur traders roamed back and forth across the country they used the waterways. Settlers also came to the region by way of lakes and rivers. A stream of settlers came down the Ohio to the Mississippi and up the Mississippi to St. Louis. From St. Louis some pioneers went up the Missouri River, while others went by the upper Mississippi. Another stream of settlers built their log houses along the shores of the Great Lakes. There is no high land between the Mississippi Basin and the Great Lakes, so that canals were soon dug to connect the rivers which flowed into the Great Lakes with rivers that flowed into tributaries of the Mississippi. A belt of settlements marked the location of these connecting streams. Another belt of settlements followed the railroads which were built across the level land. Gradually the belts of settlement became wider and wider, until almost all the land had been settled. These states are thickly populated today.

A large part of this region was a prairie covered with a dense carpet of grass. In wide belts along the streams were the forests. Today the prairie farms are generally more highly prized than the farms on land from which the trees have been removed, but the early settlers preferred farms in the forests. Why did they prefer to go to the trouble of cutting down trees when treeless prairies were near at hand?

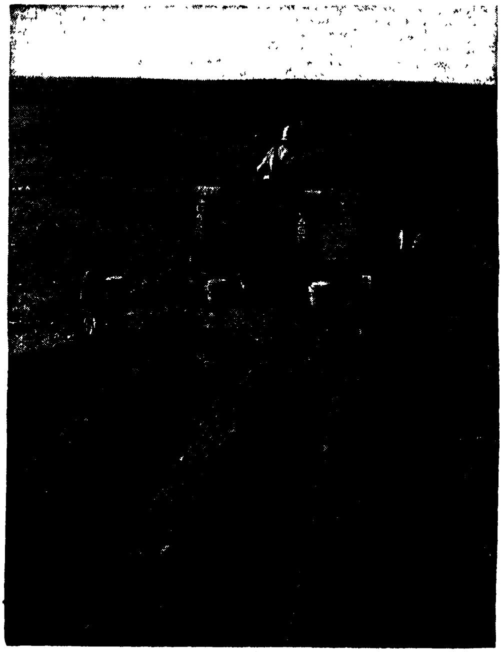
The forest gave the pioneer the logs for his home, rails for his fences, and fuel for his fire. The soil, with no thick mat of grass, was easily plowed. The forested land was generally well drained and near a navigable stream. Drinking water could be readily secured from springs and streams. Wild game for food was abundant in the forest—until, of course, all of the forest had been cut down.

The pioneer believed that land which did not support trees was poor land. Then, too, much of the prairie land was poorly drained and even swampy, and it was hard work to break up the thick sod with its tangled roots. When, however, people discovered the wonderful fertility of the prairie soil, these grasslands rapidly became settled.

As soon as possible the early settlers planted wheat. The rich soil and the smooth surface were favorable for wheat. After it was sown little further work was necessary until harvest time. Then it was ground into flour for home use, and the surplus crop could be shipped to the East. Wheat has good keeping qualities and is not harmed by cold winter weather.

Kansas is now the leading wheat state in the section. Strange as it may seem, the wheat is planted in the fall, just a few weeks before the coming of the long, cold winter. The cool weather and fall rains are helpful to the plants when they are small. They send out many roots into the ground, and lie in the ground as if asleep during the winter season. They can stand very cold weather if the change is gradual, and during the coldest part of the winter a blanket of snow usually protects them.

When the cool, moist weather of spring comes, the plants wake up and begin to grow. They grow very quickly because of their large root systems. Gradually the weather grows warmer and the ground is moistened by occasional showers. Warm, sunshiny weather should come when the seeds are ripening. Although occasional periods of drought and other periods of too much rain at the wrong time have brought destruction to the crops, soil and weather conditions in Kansas are usually such as to permit the growing of large crops. Wheat planted in the fall is called winter wheat, and most of the wheat grown south of the



Courtesy, J. I. Case Company

This planter sows corn seed as it digs the furrows.

Louis R. Bostwick

By harvest time an Iowa cornfield looks like this.

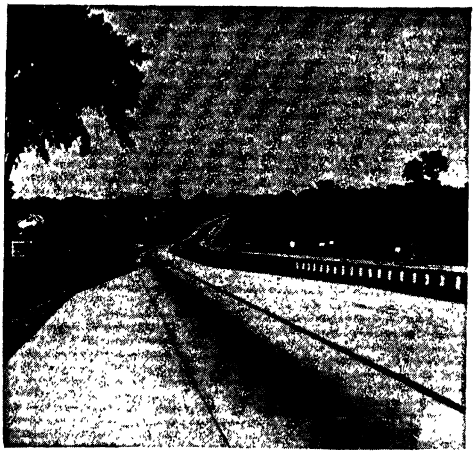
latitude of Chicago is likely to be this kind.

An enormous amount of wheat is also grown in the states north of the latitude of Chicago, especially in North Dakota, South Dakota and Minnesota. Even farther north, beyond the United States boundary line, stretches the vast wheat-growing area of western Canada. Much of the wheat grown throughout this northern area is of the kind known as spring wheat. About one-fourth of the wheat produced in the United States is spring wheat. Let us take the state of North Dakota where all of the farmers plant their wheat in the spring. There is a reason for this.

Cool, moist weather in the fall is less certain here than it is farther south, and freezing weather comes earlier. The winters are cold, and a cold wave may come when there is no protective blanket of snow on the ground. If the wheat were planted in the fall, there would be danger of its being winter-killed.

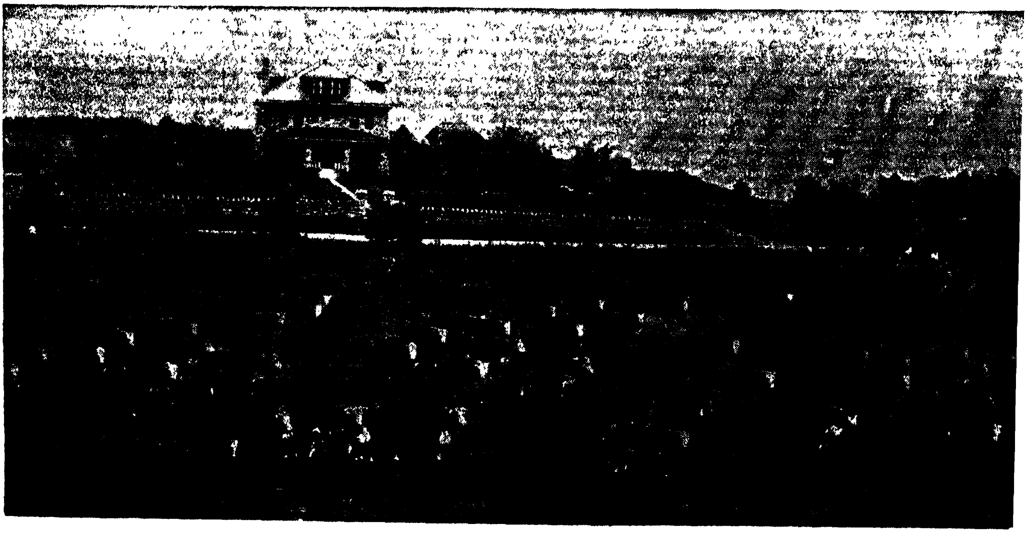
The North Dakota farmer plows and harrows the ground in the fall. Many insects which have burrowed into the ground for the winter are brought nearer the surface by the plowing and are killed by the cold winter weather. Plowing and harrowing in the fall also makes it possible to plant without delay as soon as favorable spring weather arrives.

A large part of the rain in this section comes in the spring and early summer. The cool, moist weather of spring helps the plants to grow and to send up many shoots, which will bear seeds. During the summer, hot, dry weather becomes more frequent, and when the wheat begins to ripen, later on, the hot sun shines down on it during the long days of the northern summer and brings it quickly to maturity.


Courtesy, Indiana Dept. of Conservation
A modern two-lane highway passing an Indiana farm.

So we see that winter wheat is planted in the southern part of the North Central states and spring wheat is planted in the northern part, because of the differences in the weather conditions. Man tries to carry on his work so that Nature will help him.

The wheat farmer may try just as hard one year as another to produce a big crop,


A herd of Herefords, sometimes called "white faces" for a very good reason, is shown here grazing on a stock

but the total amount of wheat produced varies somewhat from year to year. No two growing seasons are exactly alike. The ground may be too wet or too dry to plow and harrow; the wheat may be planted too late or too early; a cold wave may find the field without a snow cover; hot, dry weather or cool, wet weather may come at the wrong time. Hessian flies, chinch bugs, grasshoppers, rusts and smuts may reduce the yield; wind storms or hail may flatten the plants and shatter the grain; weeds may choke the wheat plants so that they can not grow.

In the early history of our country, from 10 to 30 acres of wheat was a large field. Today, it is not unusual to find farmers with 80, 160 or even 320 acres of wheat. When wheat was first planted in this region, a "walking" plow was used, which turned up only one furrow at a time. A man walking behind the plow could cover no more than an acre or two a day. Then, when that was done, the ground had to be gone over again with the harrow. Today, many horses, or the powerful gasoline tractor, may pull a gang plow which turns up many furrows at one time. The disc, with saucer-like blades, is drawn behind the plow and breaks up the clods into fine pieces. One man can plow and harrow 20 or more acres in a day.

Formerly, the cradle, an improvement of the scythe, was used to cut the wheat, and one man could cut four acres or less in a day. Now, a binder pulled by a tractor cuts a wide path across the field and ties the cut grain into bundles. The bundles, or sheaves, are dropped upon the ground, four or five in one place. After drying out they are carried to the thresher. On large farms the "combine," drawn by a tractor, is much used. It will reap and thresh forty to fifty acres a day.

Man has learned how to make and use farm implements, but gang plows and binders would be of little use in a rough or rocky region. The states of the North Central region have a large area with a smooth surface and a fertile soil. Nature has made it possible for man to use plows, reapers and binders which enable him to do many times the work of the walking plow and the cradle of earlier days.

The twin cities, Minneapolis and St. Paul, in Minnesota, are so called because they face each other, on opposite banks of the Mississippi. These cities are not in the center of the spring-wheat region, but on the eastern margin; yet from the beginning their prosperity has been closely related to the spring-wheat for this reason.

When settlers entered the grasslands to the west of the Mississippi River it was necessary to bring in lumber. Tributaries of the upper Mississippi extended into a heavily forested country, and logs could be floated downstream to the Falls of St. Anthony, where water power was used to saw the logs into boards. Minneapolis is on the Mississippi River at the Falls of St. Anthony. The settlers to the west came to depend upon Minneapolis for their lumber and farm tools.

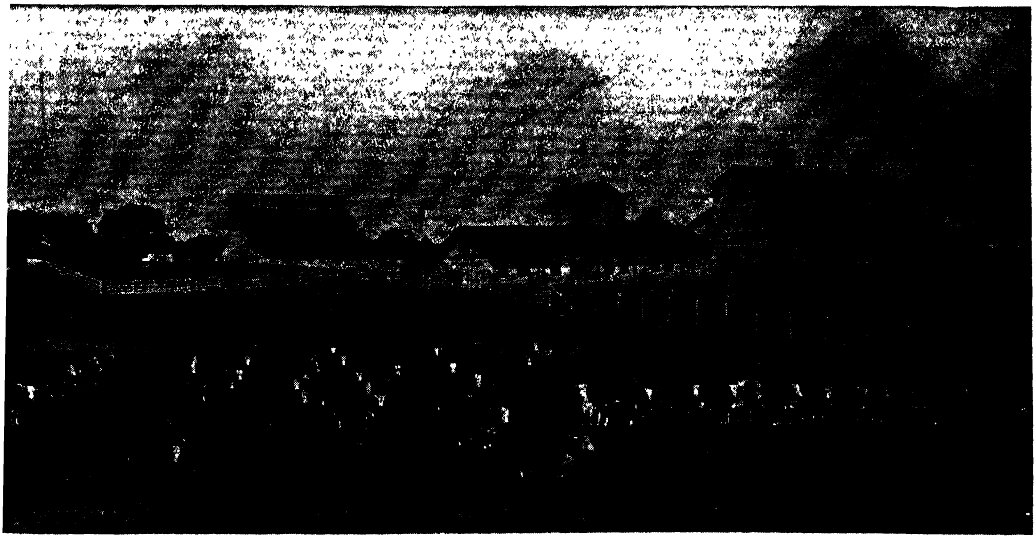


Photo by Smith & Morton

farm in Jackson County, Missouri. Some of the finest cattle in the country are raised in this region.

Courtesy, H. J. Heinz Company

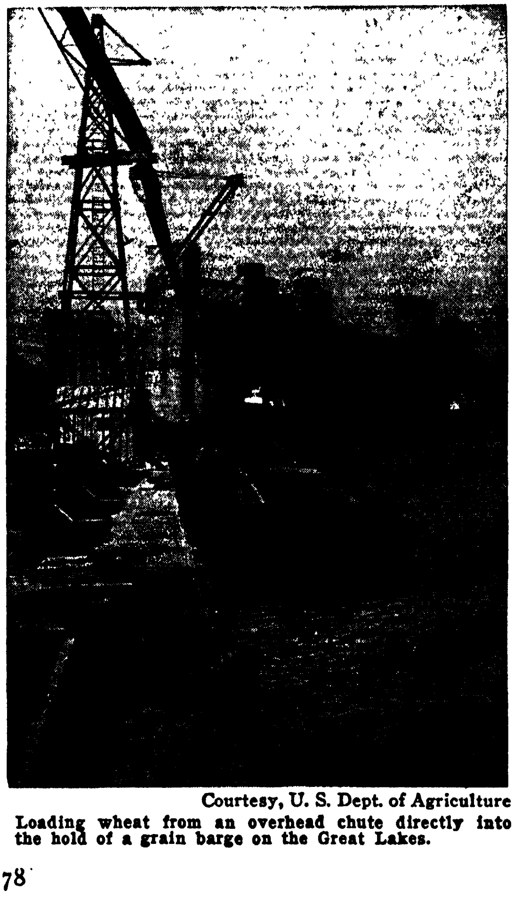
Girls sorting tomatoes in this modern cannery make sure that no spoiled fruit gets into the juice or soup or catsup canned here. Ohio has many canneries.

The settlers soon found that wheat was their best-paying crop, and took some of it to the head of navigation, a short distance below the falls, and sent it down the river. At the head of navigation St. Paul was founded. Much of the wheat, with the help of cheap water power, was made into flour at Minneapolis, and sent eastward to the consumer. In the beginning, flour from spring wheat was not so highly valued as flour from winter wheat, but in 1878 the first complete roller flour mill in the United States was constructed at Minneapolis. By this new method it was possible to make better flour from spring wheat than from winter wheat. Minneapolis has become one of the greatest flour-milling centers in the world. The twin cities lie between the spring-wheat region and the manufacturing cities to the east. They not only receive the products of this agricultural region, but also distribute manufactured goods.

Every state produces some corn, but the heart of the Corn Belt extends from eastern Nebraska to eastern Ohio. It includes Nebraska, Iowa, Missouri, Illinois, Indiana and Ohio. These six states produce about half of the corn crop of the United States. With parts of some of the adjoining states this area is known as the Corn Belt.

Except for the easternmost part, the prairies include most of the Corn Belt. This region is almost level, or gently rolling land, and modern farm implements can be used on it to great advantage. Much of the soil is a rich loam, left there after the melting of a great sheet of ice, which once covered the whole area of the North Central states many thousands of years ago.

Some of the land that the early settlers found was poorly drained, but surface ditches were dug, and thousands of feet of drainage tile were placed underground. The glacier had left a topsoil of ground-up rocks rich in plant food. Through the decay of prairie grasses, much humus, a dark brown substance, was added to the soil. Corn



Courtesy, U. S. Dept. of Agriculture

Loading wheat from an overhead chute directly into the hold of a grain barge on the Great Lakes.

grows best in the loamy type of soil formed in this way.

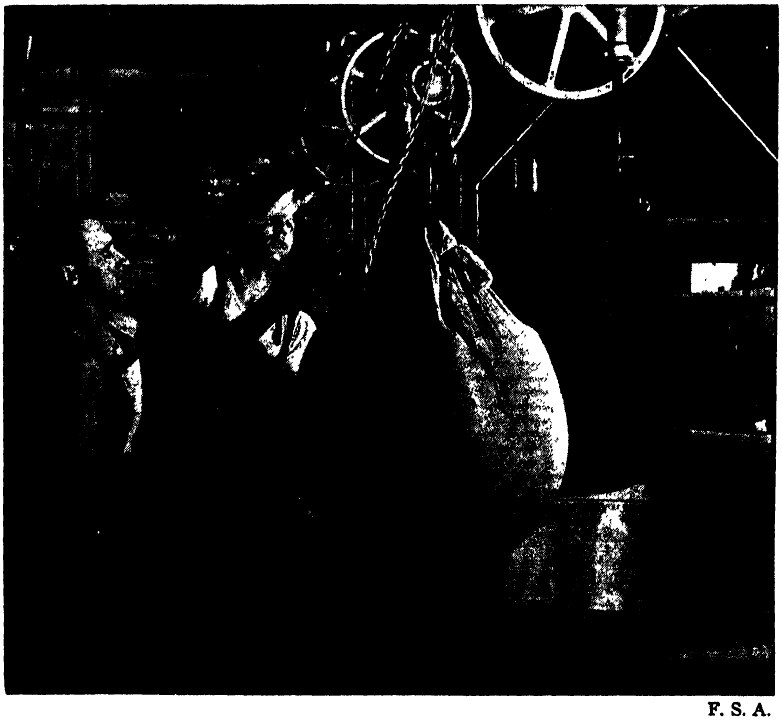
Corn requires about five or six months of growing weather. The nights as well as the days should be warm, and there should be frequent rains followed by sunshiny weather. Cool, frosty days in the fall help the ears of corn to cure properly. These weather conditions are found in the Corn Belt. In fact, it is the largest continuous area of suitable corn, or maize, land to be found anywhere on earth. Nevertheless, weather conditions are not always ideal, and many insect pests and diseases have to be continually fought against.

To the north the growing season is shorter, and corn will not always ripen, although corn is grown. Much of the land is given over to pastures and hay fields. Large dairy barns dot the landscape. The Corn Belt to the north gradually merges with the dairying belt, which stretches from Minnesota eastward to the Atlantic coast. Many large cities near at hand need fresh milk, while butter and cheese can be shipped long distances.

Perhaps you may wonder what green corn has to do with dairying? While the corn is still good for roasting ears, or in the milk stage, the stalk, leaves and ears are chopped up together and packed in a silo. This food is good for the cattle during the winter season, when there are no green pastures. Some of the soft corn is sent to canning factories.

F. S. A.

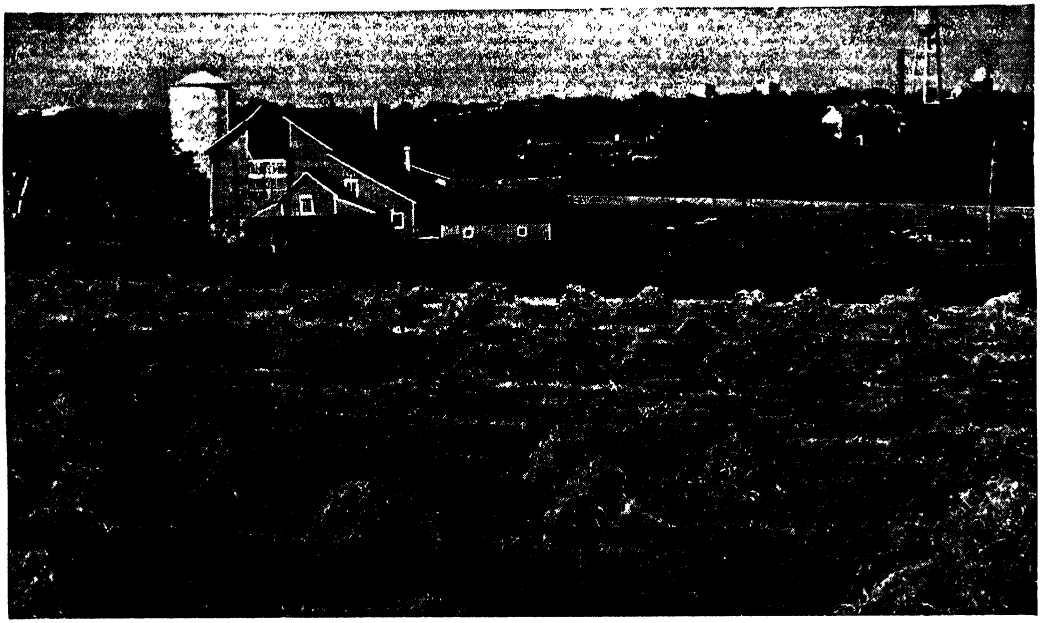
Sorting cherries on a moving belt in a Michigan plant.


F. S. A.

Straining the whey from the curd in a Wisconsin cheese factory.

To the south of the Corn Belt much corn is grown, but the growing period is long, and the strength of the plant goes to stalk and leaves. The yield is generally less than in the Corn Belt. The corn contains more water and will not keep so well in the warm, moist climate, and insect pests and diseases are more numerous than in the Corn Belt. Moreover, in the southern area cotton competes with corn for the best soil.

To the east of the Corn Belt the rugged Appalachian Highlands produce corn, but a large part of the area is not suitable for

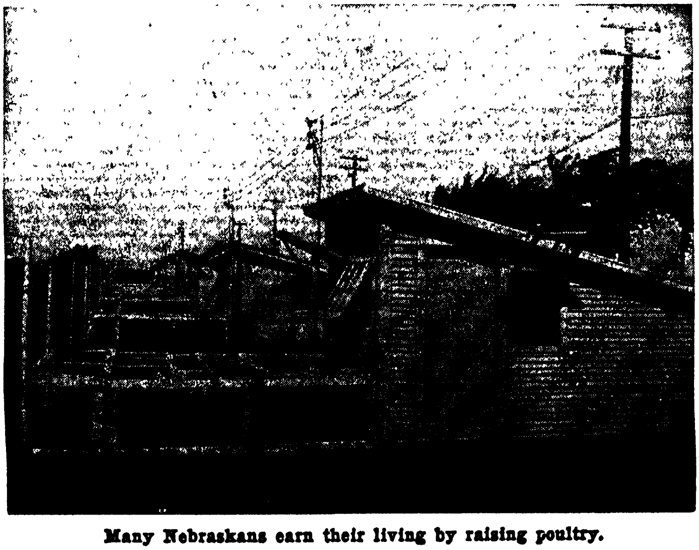


Harvest time on a Minnesota farm. In the upper lefthand corner is the silo where the farmer stores green forage.

farming. To the west the altitude gradually increases to nearly a mile above sea level on the Great Plains of western Nebraska and Kansas. The growing season is short, the rainfall is uncertain, and hot days may be followed by cool nights.

Although the United States usually produces less than a billion bushels of wheat, there is generally a large amount for export. Since the United States produces from one an one-half to two and one-half billion bushels of corn annually, you might suppose that much of the corn crop is exported. But this is not the case; only a small fraction of the crop is sold abroad. Moreover, only about 6 per cent of the total crop is used as human food. Yet the corn crop is the most valuable crop raised by the American farmers.

The larger part of the crop is used on the farms themselves. While corn is not so valuable as wheat per bushel, it costs about as much to ship, and so the farmer finds it profitable to feed his corn to livestock. He can convert four pounds of corn into a pound of pork, or six pounds of corn into a pound of beef. About 40 per cent of the corn is fed to hogs, while another 24 per cent is fed to cattle. About one-half the hogs, about one-fourth of the cattle and one-third of the poultry raised in the United States are in the six Corn Belt states. When we think of the



Many Nebraskans earn their living by raising poultry.

pork, beef, poultry, lard, eggs and dairy products that we consume ourselves, besides what we ship to other countries, we do not wonder that a writer has said that "corn is the principal source of food of the American people."

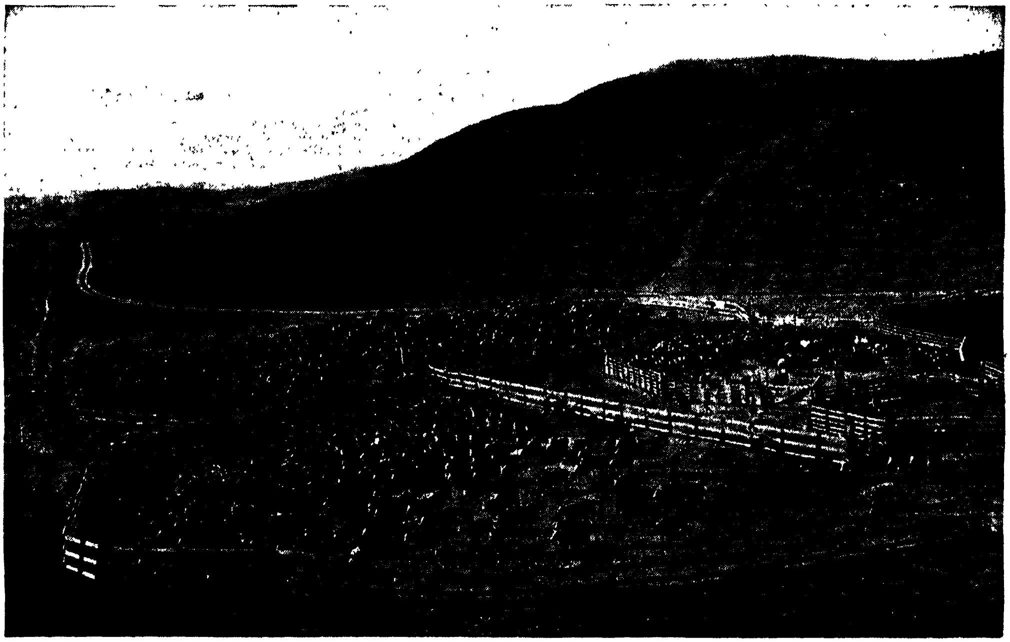
The prairie soils were so fertile that for a long time the farmers would plant the same field with corn year after year. This is not a good thing to do. The corn keeps drawing the same nourishment out of the soil, and after a while the soil becomes exhausted and will not produce such good crops. When the prairie farmers found that planting only one crop was wearing out their soil they began to take measures to build up the soil again. Planting legumes, such as alfalfa and clover, helps to restore the soil. The fields can be grazed by the cattle, hay can be made, and the green crop can be plowed under to add humus and nitrogen to the soil. So it came about that most good farmers began to rotate their crops to keep their land fertile.

In the northern part of the Corn Belt the corn is followed by crops of oats, clover and timothy. In the southern part corn is rotated with wheat, clover and timothy. In the western part, where the rainfall is less, alfalfa takes the place of clover and timothy. Hogs, cattle and sheep are fed on the alfalfa, rich in nitrogen, and the soil is further enriched through the addition of animal manures.

Spring-wheat farmers have found it more difficult to rotate their crops. They must find crops adapted to a short growing season during which some of the nights may be cool, and a long, cold winter season. The spring-wheat states produce a large part of the rye, barley and linseed crop, but these crops do not improve the soil much for the cultivation of wheat.

Potatoes yield well and are produced in large quantities, but unlike wheat, they are ruined if the temperatures get too low. In the spring-wheat country the winter comes so suddenly that thousands of bushels of potatoes may be frozen. The price offered for the potatoes may be so low that it does not pay to dig them. If the United States should turn to alcohol as a source of fuel, potatoes, from which alcohol can be made, can be raised here in almost unlimited quantities. While the long, cold winters are a handicap, it is probable that dairying will become more important in the spring-wheat states.

Although Michigan has a high latitude, it is the most important state of the North Central group in the production of fruit. A glance at a map will show you that the lower peninsula of Michigan is bounded by Lakes Michigan, Huron and Erie. The temperature of these great bodies of water changes very

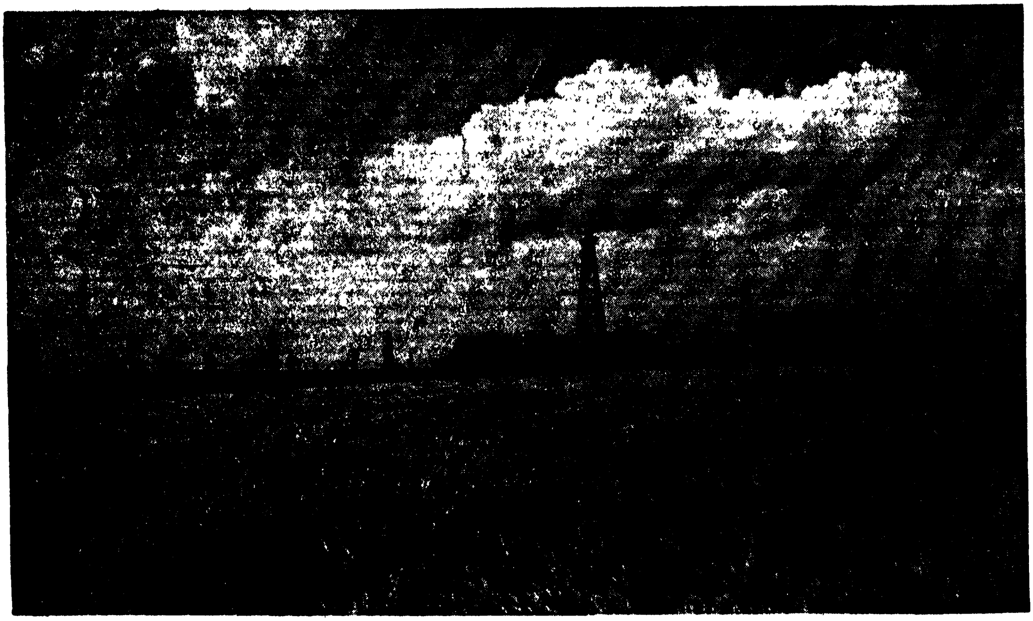


Round-up of grass-fed cattle from the range, on a South Dakota cattle ranch where cowboys still ride herd.

A crude fish house of logs where a stream pours down from the hills into Lake Superior.

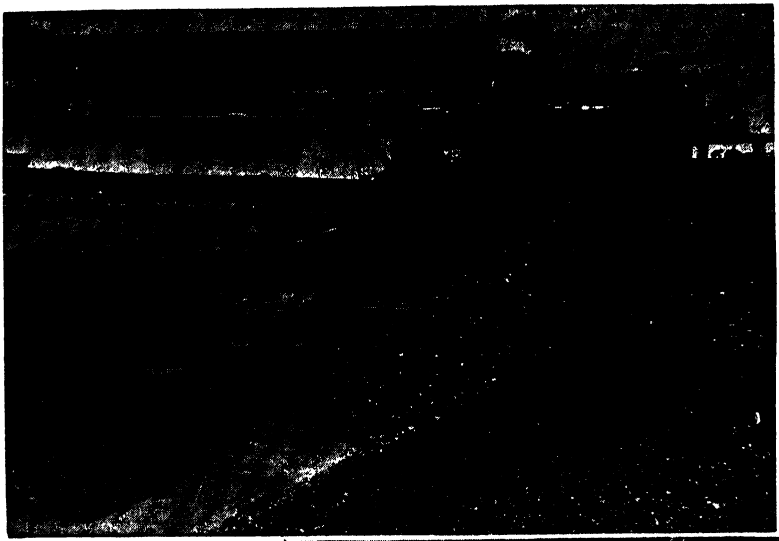
slowly. In the spring, cool winds from the lakes blow over the land. The cool air holds back the buds on the trees until the danger of frost is over. In the fall, the lakes do not cool so rapidly as the land. Lake breezes then give the neighboring land a higher temperature than it would otherwise have.

The eastern shore of Lake Michigan has a famous peach belt, but there is little fruit grown on the western shore. This is because the wind generally blows from the west. When the wind reaches the western shore it has blown over hot land in summer and cold land in fall and winter. When, however, it reaches the eastern shore, its temperature has been modified by passing over the lake. Apples, pears and grapes are hardier fruits than peaches and can be grown farther away from the lakes. Missouri, which is in a lower latitude than Michigan, has been developing its peach and apple orchards and strawberry fields very rapidly. It is probable that Missouri, "the land of the big red apple," will finally surpass Michigan in the production



Courtesy, Standard Oil Company of New Jersey

Rising from this Kansas prairie are the derricks of an oil-field whose workers probably go to the little church. Kansas is rich in deposits of such minerals as petroleum and natural gas.



F. S. A.

Chicago uses enormous quantities of coal, for it is a great industrial city. Here we see one corner of the coal docks, where the long coal barges dump their cargoes. The coal is brought from the mines part of the way by water, part by rail.

Courtesy, U. S. Bureau of Mines

In a Michigan iron mine. The ore is carried out of the mines in trains of ore cars like these, and taken to a dump to prepare for shipping to the foundries.

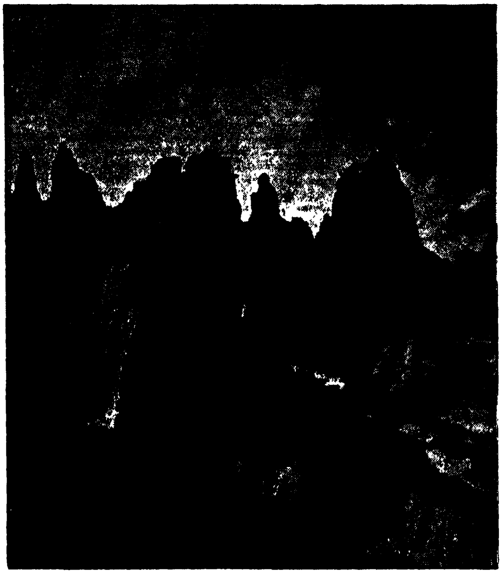
of various fruits.

Ohio, which lies between Lake Erie on the north, and the Ohio River on the south, grows a wide variety of crops. Besides the other crops we have mentioned, Ohio vineyards produce a valuable grape crop. Millions of gallons of wine and other beverages are made from Ohio grapes. Tobacco is also grown in this state, and its many flocks of sheep furnish a large and profitable wool clip each year.

The early settlers of the vast region that we have been talking about had many hardships. They had to cut down trees, clear the land and build their log houses; in the prairie lands, where there were no trees to cut down, the earliest houses were frequently built of sod. These pioneers made their own homespun clothing. They were all but cut off from the outside world; neighbors often lived far apart, there were very few doctors, and people had to depend very much upon themselves. The stranger was eagerly welcomed and was asked for news of the outside world.

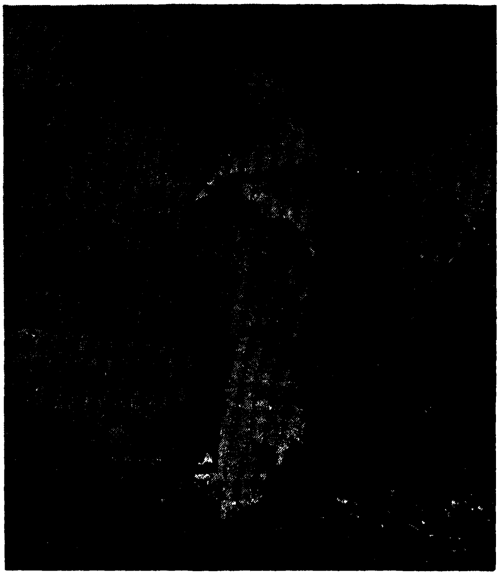
Today the farmers live much more comfortably. Mr. Jones lives on a 160-acre farm near Bloomington, Illinois, in the Corn Belt. About ten acres of this includes the house, a tenant house, a corn crib, a horse barn, a dairy barn, a poultry house, a machine shed, a garage, a water tower, a hog pen and a garden. There is a front lawn shaded by maple and elm trees. The rest of the farm is divided into fields by means of fences. The whole farm looks well-kept and prosperous.

Mr. Jones raises corn, wheat and oats, but a large part of the farm is in pasture, and there is a ten-acre patch of alfalfa. He finds it necessary to keep many hogs and cattle to help maintain the fertility of the soil. He rotates his crops, the usual order being corn, wheat or oats, clover and timothy.



Publishers Photo Service, Inc.

The Bad Lands of South Dakota, where many bleached bones of prehistoric animals are to be found today.

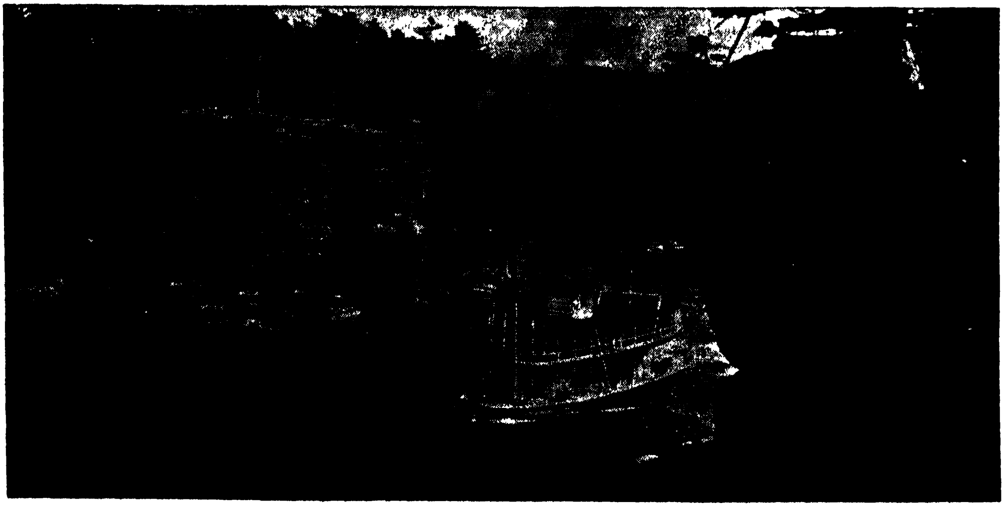


Courtesy, National Photo Co.

Indian Chief Black Hawk, a statue by Lorado Taft, stands guard on Eagle's Nest Bluff in Illinois.

A windmill and a gasoline engine are used to pump water to the water tower. Water flows from this tower through pipes to the house and to the tanks where the animals are watered. This farm has electric light, a telephone and radio. The work of the farmer and his hired hand is carried on with modern farm implements. The farmer's wife has hardwood floors, running water, a piano, and uses various electrical appliances, including a washing machine, refrigerator and iron. The postman brings the mail every day. A good road leads to the near-by village, which is on a railroad line, and farther on connects with a through highway. Similar farms extend for miles in every direction, and there is no lack of community life. The farmers of this region are busy, hardworking people, but they get a great deal out of life.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 5446.



Thousands of tourists come every year to visit the Dells of the Wisconsin River. The sides of the gorge are of a curious natural rock formation rising steeply from the river, sometimes to the height of 400 feet. The high bluff from which this view was taken is known as Romance Cliff. Many legends have grown up about the region.

SCIENCE

ENERGY FROM ATOMS

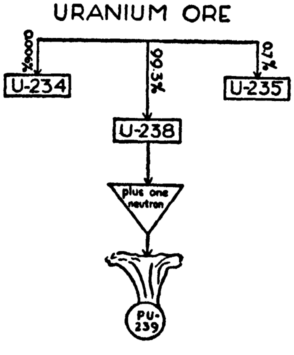
YOU have learned that all matter is made up of tiny particles, called molecules. A rod of iron, for instance, is composed of iron molecules just as truly as a brick wall is built up with individual bricks. And you have learned that each separate molecule is composed of one or more atoms, of which there exist in nature ninety-odd separate kinds. On page 313 is a list of all these different atoms, starting with the lightest, hydrogen, and ending with two new elements, numbers 95 and 96, called americium and curium. If a substance is made up of atoms of only one kind, we call it an element.

Let us look once more at the lightest element, hydrogen. Each of its atoms consists of two different particles; one is the relatively heavy proton, which is positively charged and is at the center of the atom, and the other particle is the tiny and negatively charged electron that circles rapidly around the proton. The center of the atom is called the nucleus.

Helium, the next heaviest atom, is made of three different particles. At the center, the nucleus, there are two protons and two other particles called neutrons, and circling around these four are two electrons. The neutrons are about as heavy as the protons, but have no electric charge.

The third-listed atom has 3 electrons and 3 protons; the fourth element has 4 electrons and 4 protons, and so on down the list. One of the heaviest and most important, uranium, has 92 electrons circulating around a nucleus that contains 92 protons and 146 neutrons.

Thus, we find in general that each separate natural atom has as many (negatively charged) electrons outside the nucleus as there are (positively charged) protons inside. The number of neutrons in the nucleus is not so fixed. For instance, not all uranium atoms have 146 neutrons; some have only 143, others only 142. Thus we find in nature three distinct kinds of uranium, known as isotopes of that element. The first isotope is much more abundant than the other two.

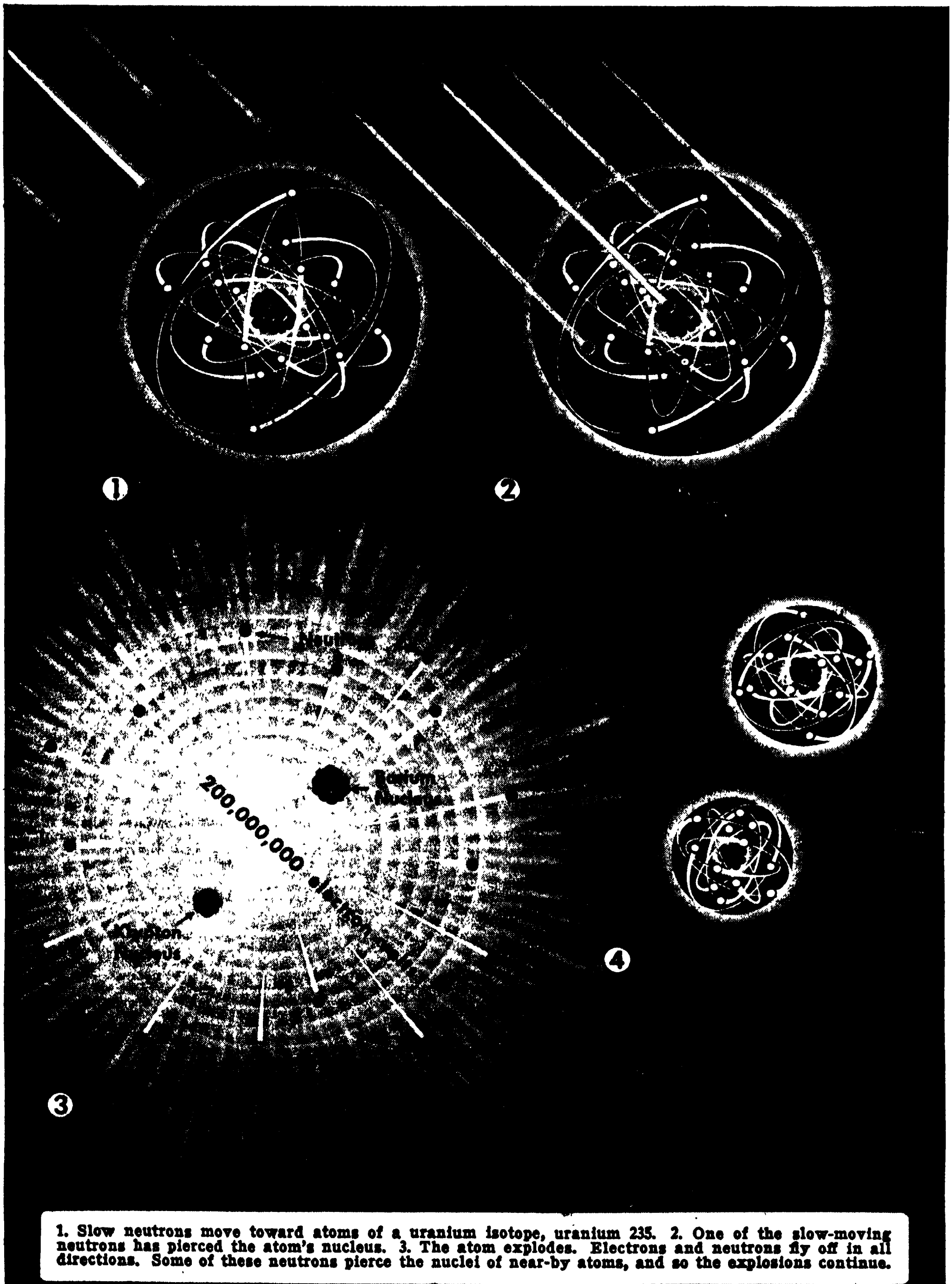


Uranium ore contains about 99.3 per cent U-238, and plutonium is made from this isotope.

Now there are two remarkable facts about isotopes. The first is that nature always mixes the isotopes of an element in the same proportions. If you took an ounce of ordinary uranium ore from anywhere in the world, you would find that most of it consists of atoms with a nucleus of 146 neutrons and 92 protons, thus having 238 units of weight, since protons and neutrons weigh the same and since the electrons outside the nucleus are so light as to be almost negligible. We call this kind of uranium U-238. But mixed with the U-238 in a lump of natural uranium are some of the isotopes weighing 235 and 234 units (one has three neutrons less than U-238, the other has four neutrons less). They are always mixed in these approximate proportions: 99.3 per cent of U-238, 0.7 per cent of U-235 and about 0.006 per cent of U-234. These isotopes of the same element are difficult to separate from each other in the laboratory because they are all alike in their chemical activities.

Another interesting property of isotopes of various elements is that their nuclei are not equally stable. In some isotopes, when left all to themselves, the atoms, by and by, all fall apart, emitting (shooting out) some of their particles at great speed. Such isotopes are called radioactive. Others do not readily disintegrate (fall apart) by themselves, but are easily knocked apart if certain particles are shot into them from the outside. You can learn about these interesting matters in the chapter on Radioactive Elements.

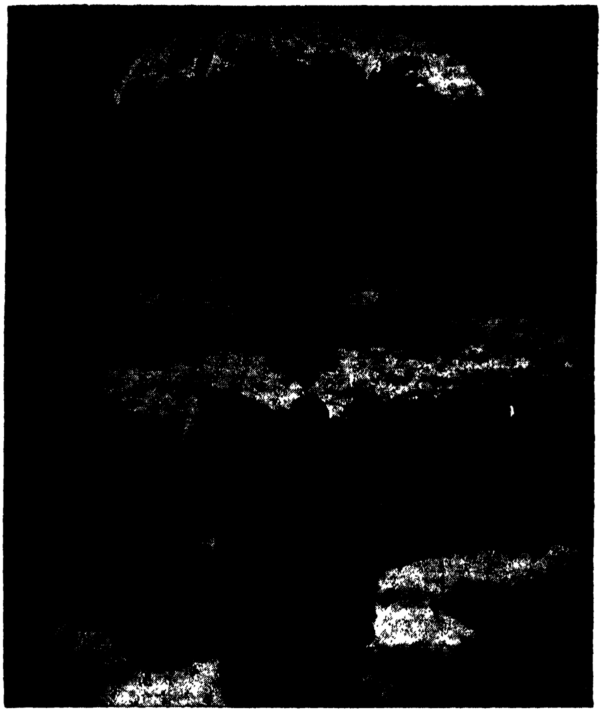
Whenever an atom disintegrates into smaller pieces, some of the matter of which the nucleus consists disappears completely; it is converted into pure energy the amount of which is relatively large. It is this so-called atomic energy which is responsible for the sun's radiation and for the power of the atomic bomb. If it were possible to convert one pound of any matter entirely into electrical energy, you could run with it all electric apparatus in the United States for a whole month. (This would require about ten billion kil-



1. Slow neutrons move toward atoms of a uranium isotope, uranium 235. 2. One of the slow-moving neutrons has pierced the atom's nucleus. 3. The atom explodes. Electrons and neutrons fly off in all directions. Some of these neutrons pierce the nuclei of near-by atoms, and so the explosions continue.

owatt hours.)

This method of creating atomic energy by destroying matter in an atomic nucleus differs radically from the usual process of obtaining heat energy by burning, or combustion, which involves only a rearrangement of whole atoms and their electrons with respect to each other.



Press Association, Inc.

A huge smoke column towered more than 20,000 feet in the air three minutes after an atomic bomb hit the Japanese city of Nagasaki.

We can now make a picture of the production of atomic energy: A lump of matter, uranium, for example, consists of uranium atoms of three kinds, namely U-238, U-235 and U-234. Their nuclei consist of 92 protons, plus 146, 143 or 142 neutrons respectively. The nuclei of these various atoms are distributed through the total lump like a cloud of stars in the sky; 92 even smaller electrons make large and rapid circles around each nucleus. Though every uranium atom has a tendency to be radioactive, it would take billions of years before half the atoms in any small lump found in nature would disintegrate by itself. Therefore we can assume here that our lump is fairly stable if left to itself.

Let us shoot into this cloud of atoms a very small particle, say, a proton. It is about 1,850 times heavier than an electron, and, like the nuclei of the atoms themselves, it is charged positively; and, as you know, positive charges repel other positive charges. Therefore this proton will be repelled from any nuclei it may approach, and be turned aside, perhaps knocking a few electrons out of their regular path, as it goes by, until it has exhausted all its energy and is slowed down. Hardly ever will the proton have a chance to collide with a nucleus.

But, if instead of a charged proton, we fire an uncharged neutron into the atomic cloud, it is not repelled by a nucleus that may be in its path, and a "head-on" collision is possible. While, therefore, protons and other charged particles can knock only chips off the "surface" of an atom, the neutron can get right inside and knock the nucleus itself apart. This is called nuclear fission.

This is the secret of atomic energy: A neutron shot into a nucleus can smash the atom so that part of its mass is converted into pure energy and the remainder forms new atoms. If a neutron having a little energy is fired into a lump that is mostly U-235, the following amazing thing happens: The first nucleus hit will split into approximately equal parts; that is, fission occurs. Each fragment of the old nucleus flies away at great speed and eventually settles down to form another lighter atom. Several neutrons that were locked in the old U-235 nucleus have no place in these nuclei of the new atoms; they are free to shoot through the rest of the atom cloud around them. They do so at very great speed because *during fission about one-tenth of one per cent of the mass of the old uranium atom has been converted into pure energy* which shows up in the great speed of these flying particles.

This explosion would not be noticeable by us if only one atom were set off. But you can see readily that the several neutrons that fly around after fission of their mother-atom may similarly set off other explosions all around them; this "chain-reaction" actually occurs in a lump of U-235 as used in one kind of the atomic bomb. Within an incredibly short time most of the billions of billions of atoms in the bomb are thus "ignited." The total effect of this sudden release of enormous energy is an atomic explosion equalling in effect many thousand times that of the ordinary explosion of an equal lump of gunpowder or TNT.

As far as we know now, this powerful "chain-reaction" occurs only in U-235 and in one other element called plutonium, which was first produced artificially. This is the way plutonium is made: Ordinary uranium ore, as found in certain portions of the United States, northern Canada, Czechoslovakia and the Belgian Congo, and containing all three isotopes, is assembled in one big pile weighing several tons. The U-235 naturally present in the pile will produce the chain-reaction we have discussed above, but at a slow, rather than an explosive, rate because many of the neutrons produced by fission of U-235 are swallowed up by the U-238 without causing any fission there. This keeps the atomic fire in the pile smoldering rather than breaking out into a big blaze.

Actually the "fire" would go out altogether if two tricks were not used. One is to insert within the pile some material like graphite blocks. Their function is to slow down the neutrons from the U-235 fission. Why slow them down? Well, it is a curious fact that these slowed-down neutrons are more effective in breaking up nuclei than are the high-speed neutrons produced by fission.

The other trick used to keep the chain-reaction going in the pile is to build it so large that only relatively few neutrons from the inside can reach the edge of the pile and escape without having hit and produced fission in some other atoms of U-235, or at least having hit and become absorbed by some atoms of U-238. That is called the "critical size" of the pile. In a pile below "critical size," so large a portion of the neutrons escape into the air before acting that the atomic fire will go out.

In such a pile, kept well supplied with fast-flying neutrons by the chain-reaction of the U-235 isotope, the U-238 atoms may "capture" neutrons without their nuclei falling apart. But then a curious thing happens to such a U-238 atom. The captured neutron, which makes the atom now weigh 239 units, by and by seems to split inside the nucleus into a proton and an electron. The tiny electron is violently pushed out of the nucleus. But now the nucleus has 93 protons instead of the usual 92 of uranium. Not long after that the same thing happens again in the nucleus (as though one tickle made the atom sneeze twice!)—another neutron in the atom splits into a proton and an electron, and the

Acme

The atomic bomb left nothing but rubble and twisted metal to show that people had once lived in this section of Hiroshima, Japan. The terrific force of the blast was felt for miles. Note the radiator in the foreground.

electron flies out, leaving 94 protons and 145 neutrons in the nucleus. This atom can of course no longer be considered uranium; it is called plutonium. It happens to act very similarly to U-235. If it is separated from the other materials in the pile that produces it, and assembled into an atomic bomb like U-235, it, too, explodes with terrific violence by a chain-reaction which spreads through the whole bomb material instantaneously.

PLUTONIUM CAN BE SEPARATED AND CONCENTRATED MUCH MORE EASILY THAN U-235

You may wonder why anyone went to all the bother of producing plutonium (written as Pu-239) for atomic explosions when it can do no more than the natural U-235 can do. The answer is twofold. First, it is very difficult to separate the isotope U-235 from U-238, since they are chemically alike; but plutonium is an element chemically different from uranium and can therefore be separated and concentrated with greater ease. And secondly, as we have noticed before, the amount of the U-235 isotope in a lump of natural uranium ore is very small compared to the amount of U-238. So it is more economical to convert the U-238 into plutonium than to extract the rare U-235 and discard the 140 times more abundant isotope U-238.

Just as a pile for making plutonium will not begin to work until it has been built up to a critical mass or bigger, so, too, a bomb made of U-235 or plutonium will not explode if its mass is below a critical size. This fact suggested an ingenious way of detonating (setting off) the bomb, namely, by suddenly joining small pieces of the explosive material (U-235 or Pu-239), each below the "critical size," but more than sufficient in size when put together to spread the destructive chain-reaction through the whole bomb. For U-235 this critical size is probably a lump of less than 200 pounds mass.

Are there any uses for atomic energy besides the destructive ones? Luckily, the answer is yes. Famous scientists have predicted that not many years after man's first use of atomic energy in the form of bombs we shall have "atomic" power plants and "atomic" engines.

At first we might just make use of the enormous quantities of heat that are liberated in the uranium-and-graphite pile during production of plutonium. Actually about one million kilowatts of power can be expected from one such pile, which is not far from the amount of power developed by a large-size electric-power plant. Of course, some kind of heat engine would be used to transform the heat energy in the pile into electricity or useful work.

Later on, perhaps in fifty years, ways may be found to use atomic energy liberated in a chain-reaction directly in engines, much as gasoline fuel is now being used in combustion engines. But before this can become possible, a great deal of progress in physics and engineering will have to be made. But there are other, more immediate results of the research on atomic energy. We have learned a great deal about the nucleus and its behavior, which may open up new and better ways of using ordinary power generation. Much has been discovered about new radioactive materials and their effects in human bodies and in chemical reactions; this benefits greatly the fields of medicine, biology and chemistry.

What about the supply of "fuel" for atomic energy? Must we depend on uranium? We know that fission of single atoms can occur in several different elements, but the production of larger quantities of atomic energy *depends on a self-maintained chain-reaction* of the material used as "fuel"; and so far only uranium and uranium-produced plutonium have shown this chain-reaction. Yet the known deposits of uranium could not supply total world needs of power for an unlimited time.

THE SUN AND THE STARS MAY GIVE US THE KEY TO SOURCES OF GREATER ENERGY

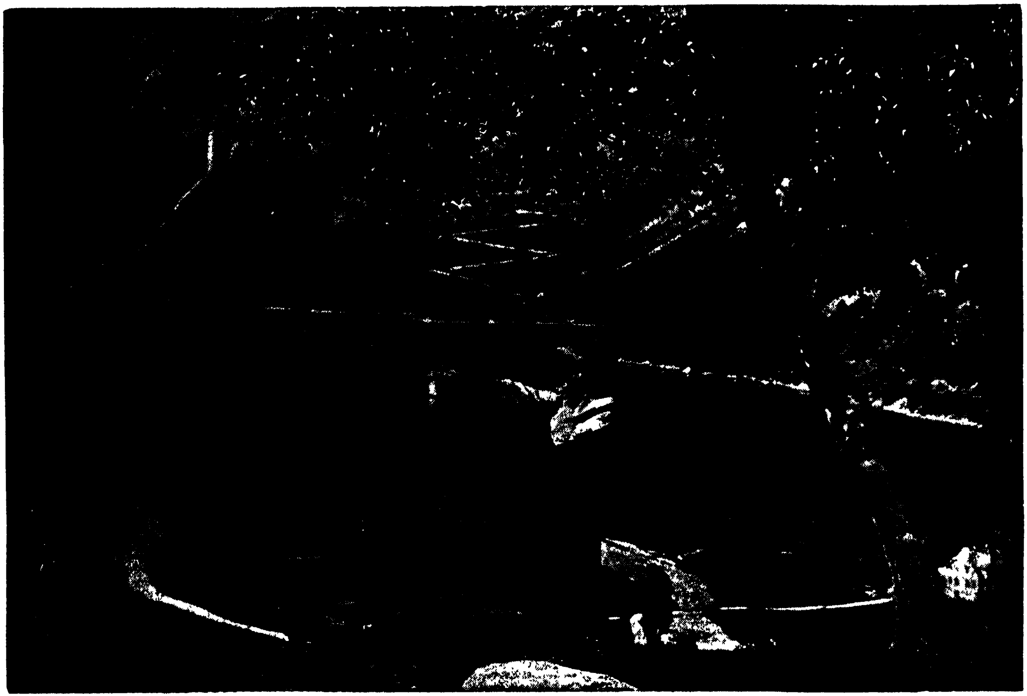
Therefore we shall have to find other ways of generating atomic energy—for instance, to try to induce chain-reactions in more plentiful and available elements such as some of the metals. Actually it is just such a process involving the nuclear interaction of carbon, hydrogen, nitrogen and oxygen which produces the enormous energies radiated by our sun and by other stars. Part, at least, of the heat in the interior of the earth is also thought to be atomic energy liberated by radioactive elements.

A third process in nature involving the kind of atomic fire that results from the destruction of nuclei is the spectacular explosion of stars which happens now and then. A whole star seems to become suddenly a big atomic bomb and vaporizes part of its mass suddenly into light and heat.

May we all succeed in making this new way of producing powerful energy a means of spreading peace and plenty to all men.

By GERALD HOLTON.

THE NEXT STORY OF SCIENCE IS ON PAGE 5367.



Swedish Travel and Information Bureau, Inc.

Waking up the echoes, which bounce from mountain to mountain along a Norwegian fiord.

SCANDINAVIA

SCANDINAVIA, the largest peninsula in Europe, contains Norway and Sweden, but the Scandinavian stock also occupies Denmark and the island of Iceland on the edge of the Arctic Circle. Though the Scandinavian peoples are now ruled as three kingdoms and a republic, their histories are so interwoven that it is better to look first at their place in history, and then at the separate countries as they exist today.

The people of northern Europe—the Teutonic races—are sometimes called the Nordic branch of the human family. In Germany, the Netherlands and Great Britain that stock is mixed to a considerable extent with other stocks, though in the main their people are Nordic; but the Swedes, Norwegians and Danes, with comparatively few exceptions, are pure examples of Nordic people.

Their languages, though now getting further away from one another, are the same in origin. Their religion, before Christianity reached them, was much the same throughout the various tribes. Their mythology and early poetical history is common to all. Their character and ways of living were alike, whether they had their homes on the Danish and Norwegian shores of the North Sea, the Scandinavian fiords of the North Atlantic or the lower coasts of the Baltic. All of them believed when they saw the bright rainbow in the sky that it was the bridge by which the gods rode to their home, Asgard; and when they heard the roar of the thunder, to all it was Thor the Strongest rattling past in his cart or banging his great hammer. Like the Angles and Saxons, they, too, believed that the great All-Father Odin, or Woden, received those slain in battle to feast forever in his great hall, Valhalla.

War was their principal occupation, and the chiefs went on fighting each other for desirable tracts of land that gradually grew into small kingdoms. At last a sudden activity stirred in the hearts of the dwellers of the fiords and some of their neighbors.

Like a destructive tempest these wild raiders swept round northern and western Scotland to northern Ireland, to the Isle of Man and the coasts of Cumberland; they divided northern England on its eastern side, from Northumberland to the Wash, with their Saxon cousins, who had come there, like themselves, as adventurous invaders centuries before and had settled in the land. They seized the part of France now called Normandy (after them), and made their way up the Seine till they threatened Paris. They penetrated far into the Mediterranean. They crossed from the Baltic to Constantinople by way of Russia, and founded kingdoms as they passed along. The first king in the dim beginnings of Russian history was Rurik, a Northman from Sweden, who was crossing Russia toward the east when the Russians asked him to stay with them.

"From the rage of the Northmen, deliver us, O Lord," was the prayer that rose up from far and near, as churches and farms were burned, and people were killed or enslaved, while their worldly goods were carried off to the high-prowed Viking ships.

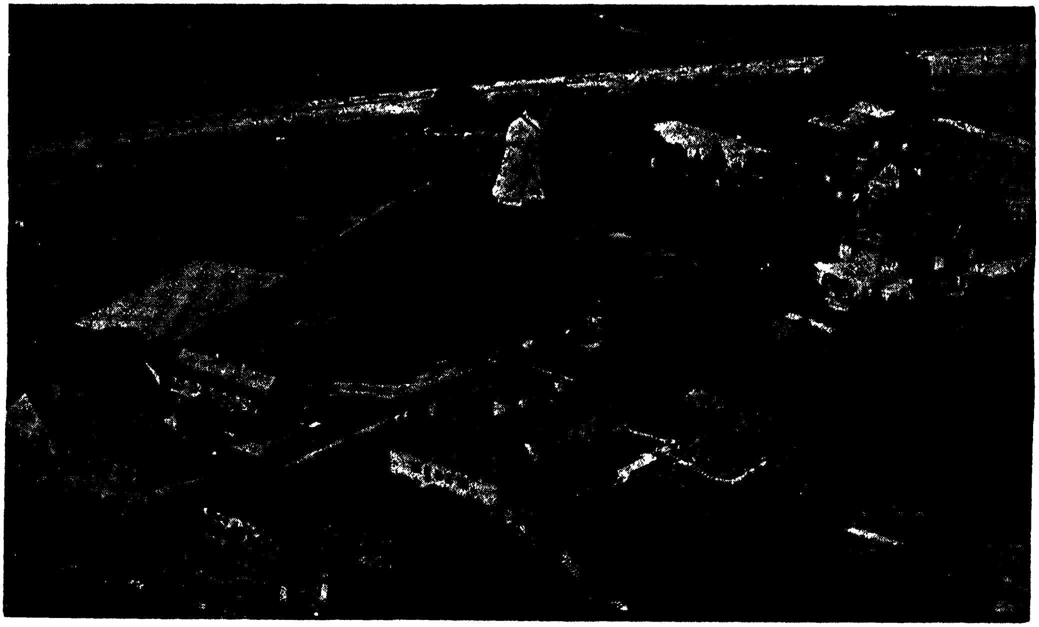
The Northmen made their homes permanently in Iceland, and from there sailed away to the north and west and discovered Greenland. From Greenland they reached America nearly five hundred years before Columbus discovered it again.

These men who, a thousand years ago, lived by the belief that the only honorable ending of life was a violent death, were the ancestors of the Scandinavian stock, which from its Norwegian branch sends more people to sea and owns more ships in proportion to its population than any other nation in the world.

But it would be difficult to imagine a people more unlike the fierce Viking raiders of a thousand years ago than the Swedes, Danes and Norwegians of today. That the qualities of daring and steadfastness remain deeply and firmly in their natures has been proved through all the centuries since they gave up their pirate rovings.

They have a terrible record of wars, though they did little fighting in the eighteenth and nineteenth centuries. Few in number and never rich, they waged with desperate bravery, and only partial success, wars far beyond their strength. At length they settled down to live in their own native lands, with all their conquests lost. But they had given stronger nations the impression that it was best to leave them alone.

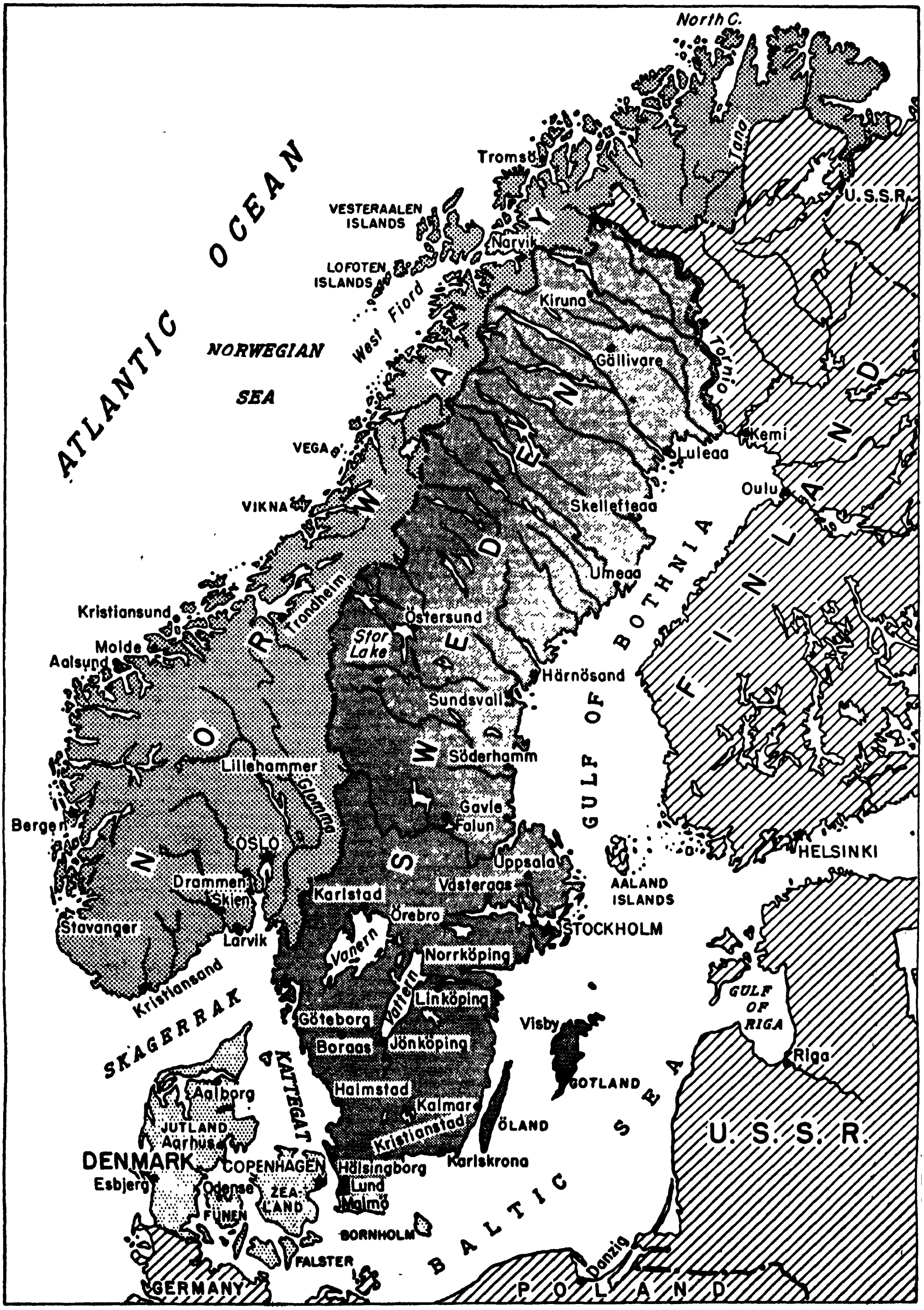
The Dane, the Swede and the Norwegian, in education, courtesy and the practical use of the resources within their lands were in the front rank of civilization, until the pressures of World War II forced Norway and Denmark into subjection and seriously crippled



Danish Information Office

A corner of a tidy village on the Danish island of Zealand, not far from Copenhagen, the capital.

NORWAY, SWEDEN AND DENMARK



Mountain ranges separate Norway from Sweden, and little Denmark is separated from both by bodies of water.

Sweden's trade, one of the greatest sources of her prosperity. Let us glance at the history of these states, from their days of pillage and adventure and conquest to the present time.

Very little was known of the Scandinavian peoples by the Romans. Mediterranean civilization was cut off from the north by the Nordic tribes of Germany. Christianity did not reach either Denmark or Sweden till about 1000 A.D.

In the meantime, in the big and little peninsulas, and on the islands between them, the three kingdoms were gradually settling down. For about four centuries, from the tenth to the fourteenth, they kept fairly distinct and independent of each other. For a time, however, the kings of Denmark—Sweyn and his son, Canute the Mighty—were practically emperors of the North, ruling over Denmark, Norway and part of Sweden, and forcing the Anglo-Saxons of England to accept them as kings.

OLAF, THE KING WHO CAME TO BE REGARDED AS A SAINT

Sweyn's father had adopted Christianity for Denmark. In Norway, about the same time, there were two kings named Olaf, whose doughty deeds forced Christianity on their unwilling people. The second Olaf, with the flaming red beard, is St. Olaf. This great hero of Norway, for his adventurous life, and still more for his tragic death, took firm and lasting hold of the imagination of his fierce countrymen.

After helping Ethelred of England against the Danes, Olaf bided his time till he could establish his claims to his father's throne. Facing his angry people, who objected to his reforms, he struck down their idol with his club, and after many battle cries of "Forward, Christ's men, Crusaders, the King's men!" and "Forward, forward, peasant men!" Olaf fought his last desperate fight, on August 31, 1030. The date is fixed because as the King died there was a total eclipse of the sun, terrible to the peasants, who thought it a sign of God's anger. St. Olaf was buried at Nidaros, at the mouth of the Nid, on the Trondheim Fiord.

It was in the days of the Olafs that Leif the Lucky sailed away to the west, and was the first Europeon to discover Greenland and part of the shores of North America.

Another name stands out in these early days—that of Sverre, who led the Birchlegs, so called from the bark they bound round their legs, against the Baglers who represented the nobles, in wild contest for the kingdom. The bravery of Sverre and his Birchlegs was splendid; the old historians tell us how Sverre put down the nobles who oppressed the people, and how he maintained law and order, after long and fierce fighting by sea and land.

The Bagler chief with whom he last fought had been on a Crusade to Constantinople and Jerusalem. When the two, both ill, were lying side by side on the ship's deck that was taking them to Bergen, as they gazed at the clouds fleeting across the wintry sky, the conquered Bagler told his conqueror, Sverre, about his wonderful adventures in the east and the glories of Constantinople. Sverre was one of the greatest kings that ever ruled over Norway. Two centuries after his death, all three kingdoms were united for about 125 years under the rule of Denmark.

The union, though marked by Swedish rebellions, continued till 1523, when Gustavus I, who was elected king, resenting harsh government by the Danes, began a separate career for Sweden which made her mistress of the Baltic.

Gustavus was a Protestant, and he and his grandson Gustavus Adolphus became champions of the reformed faith. The aim of the Swedes was to shut out Russia from the Baltic Sea and to be masters of northern Germany. Up to the middle of the seventeenth century they succeeded so well that Sweden was mistress of that part of the world, and unquestionably one of the great powers of Europe. But she was attempting more than her strength, either in men or in means, could possibly sustain; and the wildly pursued wars of Charles XII, a brave soldier without any idea of diplomacy or statesmanship, brought his country to ruin and loss.

DENMARK LOSES THE PROVINCE OF SCANIA TO SWEDEN

Denmark, too, in the seventeenth century engaged in ambitious wars, partly because her kings were jealous of the Swedish kings' championship of Protestantism. In the end she was obliged to give up to Sweden the provinces on the eastern side of the Sound which she had long held. These included Scania, the province that gave the whole peninsula its name.

Into all her wars Denmark carried her companion state Norway, whom she treated very much like a poor relation, though Norway was enriching the national life, particularly in literature. When the Napoleonic Wars broke out, Denmark joined with Na-

Danish Info. Office

Some of Denmark's famous cheeses are stored to ripen. The temperature and moisture in the storeroom must be just right.

A modern, well-lighted dairy barn. Most of the farming in Denmark is scientific. Most products are marketed through co-operative associations.

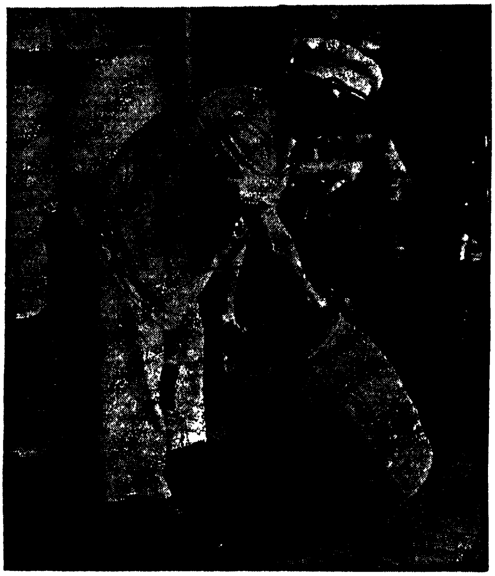
poleon in his plans that were directed against England and her commerce. The result of this was that in both 1801 and 1807 the British captured Copenhagen and the Danish fleet.

The action of Denmark in supporting France led to her loss of Norway. One of Napoleon's marshals, Bernadotte, had been chosen by the Swedes to be their king. Bernadotte, feeling sure that Napoleon would lose his fight against the rest of Europe, offered to bring the Swedish army into the war against Napoleon if the Allies would promise to take Norway from Denmark and give it to Sweden. The bargain was struck and carried out. Bernadotte helped to overthrow Napoleon at Leipzig, and received Norway as his reward, without the Norwegians being asked whether they wished to remain under the Danish crown or be transferred to Sweden. So, for ninety-one uneasy years, from 1814 to 1905, Norway and Sweden were under the same king, though separated by sentiment and rival interests.

Finally Sweden gave up her objection to Norway's withdrawing from the union, choosing rather to have a friendly neighbor than a resentful member of her household. Whereupon the Norwegians selected Haakon, a son of the King of Denmark, as their sovereign. Haakon's wife was a daughter of the English King Edward VII.

And so all three Scandinavian kingdoms became once more as independent of each other as they were at the beginning of their history. However, in the spring of 1940, Germany occupied Denmark, and conquered Norway; so, in a sense, these two came together again under one rule until the end of the war. Haakon, the king of Norway, fled to London. Sweden was, by reason of her position on the map, forced to trade with Germany almost exclusively, though she kept her independence.

In 1945, when Germany was defeated, Denmark and Norway became independent once more, and Sweden was again completely free. Let us look at each of these countries in turn.



Three Lions

Danish butter for export, made near Copenhagen.

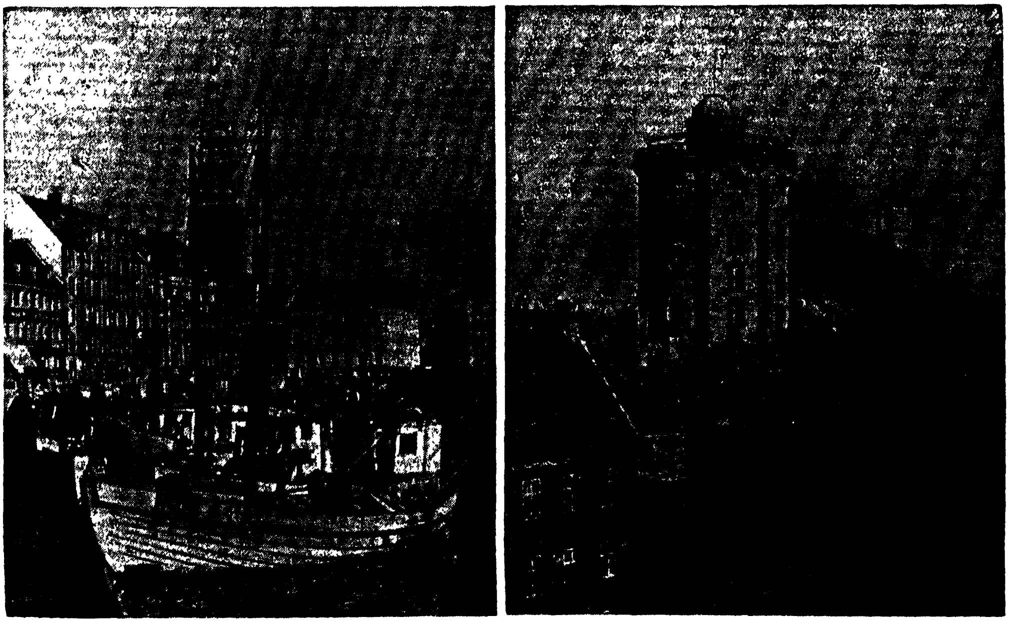
DENMARK AND ITS PEOPLE

Denmark has a population of more than four million people, living in scattered lands whose total area is about twice the size of Massachusetts. These lands, consisting of a peninsula pointing northward (an unusual direction) and about a dozen islands, half of them quite small, block the entrance to the Baltic Sea. There are only three waterways through the islands, the Sound, the Great Belt and the Little Belt. The first is between Sweden and the largest island of Zealand; the second, between the islands of Zealand and Fünen; the third, between Fünen and the peninsula of Jutland. All are easily commanded from the shores, and really belong to Denmark.

This position right athwart the entrance to the northern European sea has given Denmark importance on the sea. Only Germany has solved the problem, by cutting the Kiel Canal between the North Sea and the Baltic Sea through the state of Holstein. In the north, Denmark as a controller of waterways resembles Turkey in the south, and so she has been drawn into wars by the attempts of more powerful nations to use her as a well-placed ally, able to hinder the passage of fleets. That was Napoleon's view, but it failed.

Apart from her position astride the seas, and close to very fine fisheries, Denmark has no natural advantages that give her a lead over other nations, though she does lead them in some respects. Where she has succeeded the means used have been the education, intelligence and power of organization of her people. In agriculture, especially, she has found use for these qualities; as an agricultural nation she has no superior.

The country is flat, though not completely level. The western coast is partly shielded, like Holland, by islands, and its sandy shores have to be guarded against inroads of the sea. Denmark has no mineral wealth that can be used in manufactures, but its soil is for the most part fertile, especially on the islands on which the larger part of its people live. It is fairly well wooded, chiefly with beech, and its agriculturists, on their small farms, by scientific study and finely organized co-operative work and marketing, have won a good name everywhere by the consistent quality of their produce. Danish butter and bacon can be relied on for a sound standard of quality, and so they always command a fair selling price. Indeed, the Danes, by intelligent combination of crops, reached a steady prosperity that may well be envied by farming communities elsewhere. Immense quantities of butter, bacon,



Danish Information Office

Copenhagen means "merchant's haven." The city is built on parts of two islands, the channel between making a fine harbor. Right, the Round Tower, built about 1640, was long used as an observatory.

Left, a Copenhagen flower-seller. Right, the "Organ Church," in Copenhagen, built to honor Bishop Gruntdvig (1783-1872), famous in his native land as a poet and historian, as well as preacher.

hams and eggs were regularly sent to Great Britain and Germany, before Germany stopped the British trade in World War II.

Denmark supplies largely her own wants in cereal and root crops—potatoes, oats, rye, barley and wheat being extensively grown; and her cattle-rearing is successful. Her prosperity, widespread if modest—for she does not produce millionaires—is based on the education and thoughtful industry of her people, and she attains comfort if she falls short of riches.

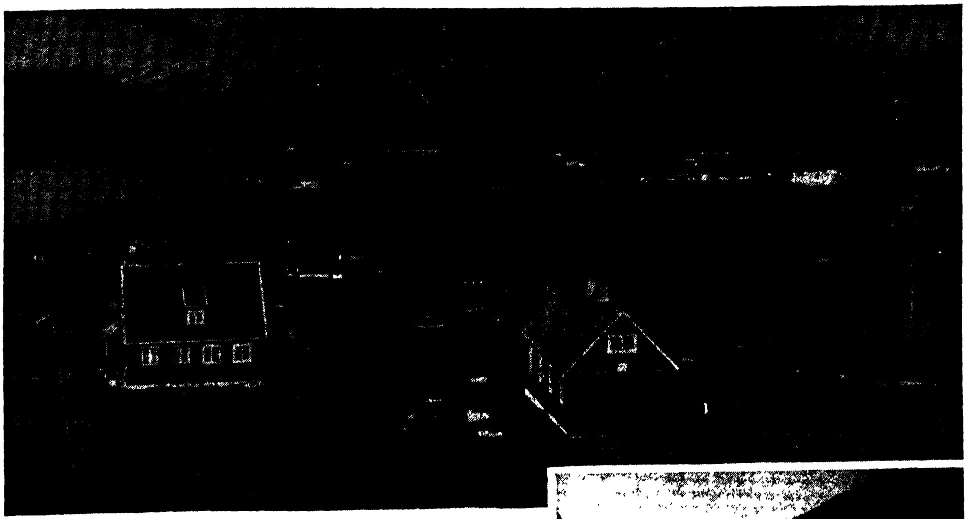
Physically, the Danes are a fine people, tall and athletically trained. With an easy independence of bearing in the country districts, they have in the towns a conspicuous courtesy in their manners and conduct.

The capital, Copenhagen (meaning merchants' haven), stands on the island of Zealand and has long been a great center of culture for the western Scandinavian peoples. It has a population of a million, or over one-fifth of the number in the whole kingdom. The popular King Christian IV added greatly to its importance, and it has very interesting museums and picture galleries. In appearance it resembles a Dutch city, owing to its flatness, nearness to the sea (it is on the Sound) and its canals. Its memories recall the names of famous Danes, such as Tycho Brahe, the astronomer; Hans Andersen, the charmer of the world's chil-

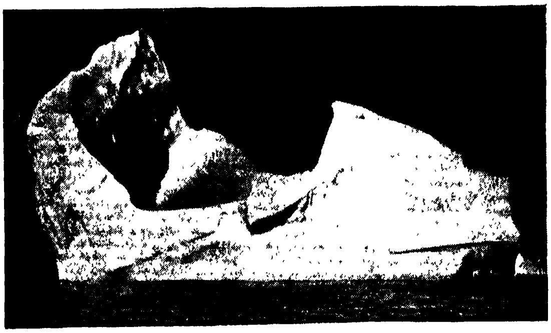
Pictures, Danish Information Office

Farmers carting pigs to a small co-operative slaughterhouse. Much Danish bacon is sold to other countries.

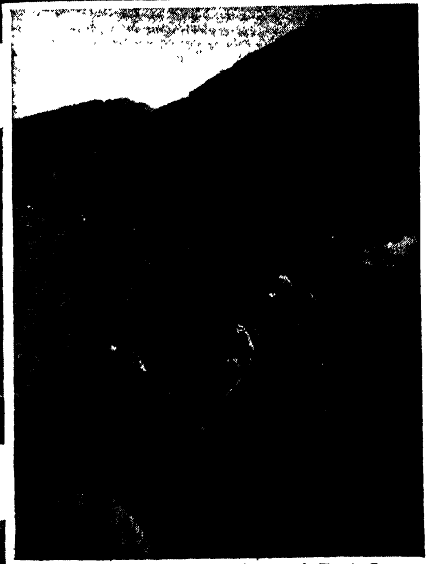
GREENLAND, DENMARK'S COLONY



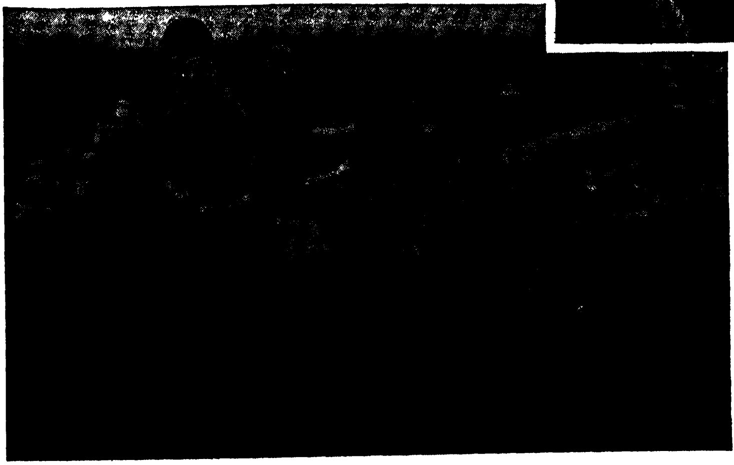
Cape York, a bleak little settlement in the northwest part of the coast of Greenland, far inside the Arctic Circle.



The icebergs of the north Atlantic come from Greenland.



Eskimos of East Greenland in their one-man boats. The center of Greenland is covered with ice. All the population lives around the shores.



Pictures, Capt. Bartlett
from Gendreau

The children of Greenland are well protected from the cold in warm suits. The pants are made of fur.

dren in fairy lore; and Thorwaldsen, the great sculptor.

There are about five hundred Danish islands, but many of them are very small and only about a hundred are populated. The most important island town is Odense, on Fünen. On the eastern side of the mainland are Aarhus and Aalborg. Helsingör, on Zealand at the narrowest part of the Sound, is the ancient Elsinore, scene of Shakespeare's tragedy HAMLET.

Besides the islands which lie between Jutland and Sweden, Denmark includes the island of Bornholm, in the Baltic, and the sheep-rearing Faroe Islands, which are the protruding tops of an undersea ridge between the Shetland Islands and Iceland. The Faroes have an area of 540 square miles and a population of about 25,000.

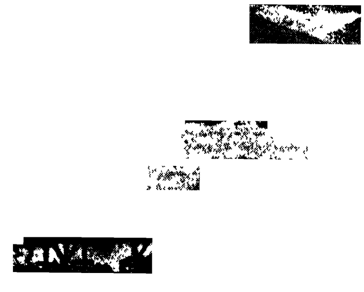
Denmark's one colony is Greenland, where 21,384 people live around the coast. The ice-free portion is about as large as England. The mother-country retains the trade of the colony under her own control. Greenland is an island extending far into the Polar Sea. It is still topped, in its elevated center, by a thick cap of ice, as all northern Europe and much of northern North America once was covered, but there appears to be a slow lessening of this mountainous coating of ice, and there can be no doubt that in the far future it will disappear entirely.

ICELAND, ONCE A DANISH COLONY

The island of Iceland is about one-fifth larger than Scotland. It has a population of over 132,000, of whom over 48,000 live in the capital, Reykjavik, on the much indented western coast. The island has many attractions for those who love to see the full variety of the earth's sights. It has the volcano Mount Hekla and hot springs that spout hot water though so near the cold Arctic. Its people are singularly attractive in their quiet industry. Among them have been preserved in purest form the oldest legends of the Nordic stock.

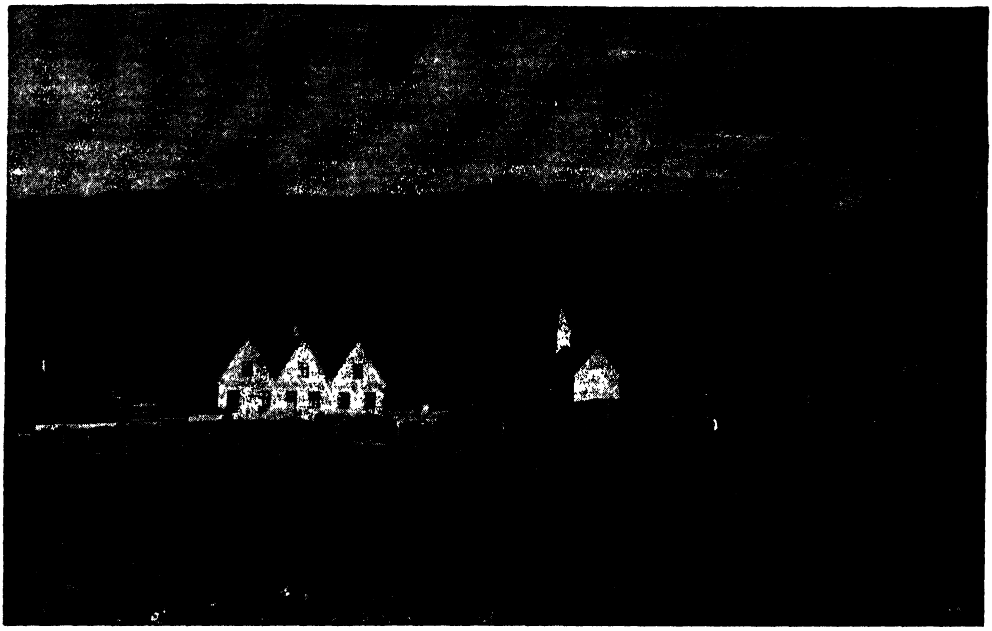
The neighborhood of Iceland abounds with fish and is frequented by all the deep-sea fishing fleets of western Europe. Indeed, fish is so much the mainstay of the island that in severe winters the cattle, sheep and ponies of the island are fed on dried fish, and have become accustomed to an animal diet.

This island was for centuries a colony of Denmark. On December 1, 1918, Iceland was recognized as a sovereign state, in a personal union with Denmark. The form of government was a constitutional monarchy, with Denmark's king serving also as the king of Iceland. This agreement was to last for twenty-five years, at the end of which time (December 1, 1943) the union could be dis-



Icelandic Consulate General

The people of Iceland get much of their living from the sea. Herring and cod are two of Iceland's important "money crops." Here we see rows and rows of barrels of herring waiting to be loaded on a cargo boat for export.



Icelandic Consul General

Iceland's parliament, the oldest in the world, was started in 930. For a long time it was held outdoors in this field.

continued if either country desired to do so.

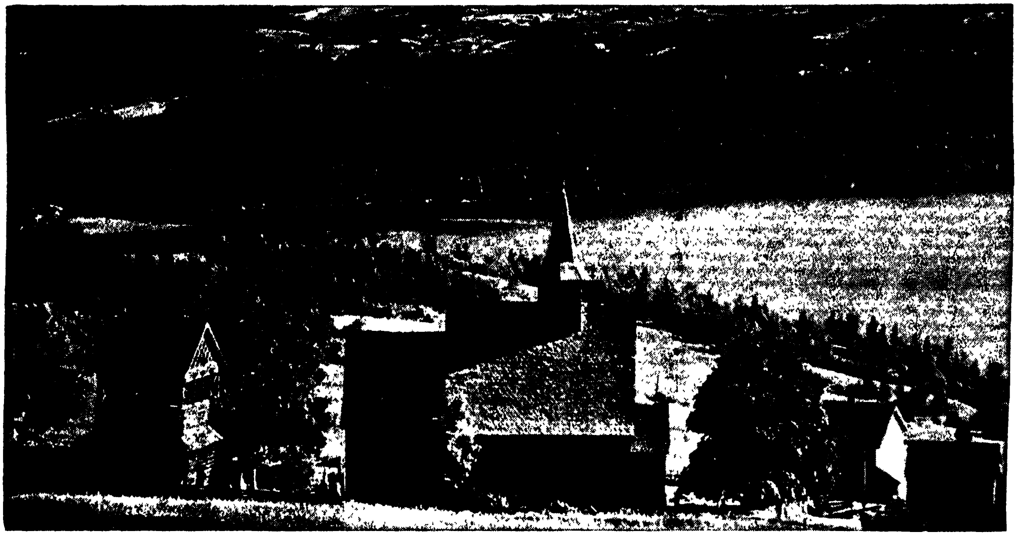
After the German invasion of Denmark, in April, 1940, the Parliament of Iceland (the Althing) voted to transfer the supreme power from the King to the Cabinet. During the remainder of the war the island was protected by Allied troops, first by British and then by American forces.

In May, 1944, the people voted to break all political ties with Denmark, and to set up a republic. The following month the Republic of Iceland was officially proclaimed.

NORWAY AND ITS PEOPLE

Norway and Sweden seem to form, in the Scandinavian peninsula, a single, compact country that might well be united in government. But if we look at the map more closely we shall perceive that the lay of the land is against any such unity. Only on the plains of the comparatively low-lying far north where the reindeer-breeding Finns and Lapps extend from Norway to Russia, is there a clear common interest.

Norway and Sweden are tilted away from each other down the slopes of a mountain range that is not easily crossed. The mountains, which are known as the Kjölen, or "Keel," resemble the central keel of a boat when it is turned upside down. The two countries look away from each other. Norway goes down one side, looking west and south, and Sweden goes down the other side, looking east and southeast. Norway is a country of the Atlantic and North Sea; Sweden is a country of the Baltic Sea. Norway has no navigable rivers; yet large ships can steam far into her interior at many places because the western sea winds its way deep into her mountain recesses. Sweden is a broad land of many waters, making a navigable network, and the quieter waters of the Baltic are fenced off from breaking deeply into her shores by a breakwater of small islands. To a large extent Norway has the same rocky defense, but the Atlantic breaks through into the deep valleys which were cut out of the steep western shore of the mountains by the glaciers that descended from the ice cap once covering Norway. These deeply cut valleys, floored by the Atlantic, are the famous fiords. And still the glaciers remain on the top of the highest parts of the "Keel." Norway has by far the



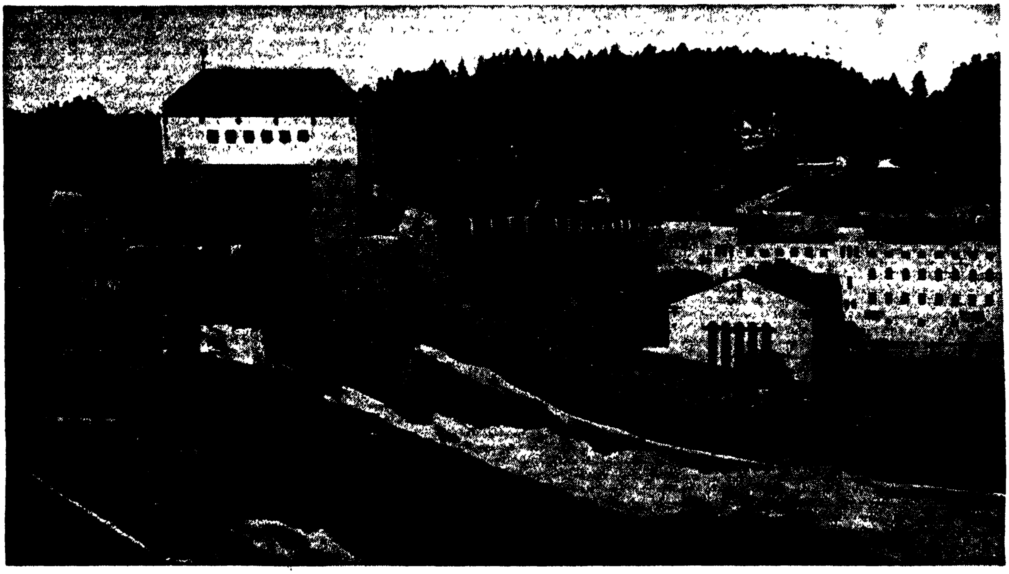
Norwegian Official photo

An 850-year old stave church and clock tower in a lakeside clearing in one of Norway's great spruce forests.

largest glaciers in continental Europe, the largest one spreading over 580 square miles.

The Scandinavian mountain range is a lofty plateau much nearer the Atlantic than the Baltic, with ice and snow on its shoulders, at heights of from 4,000 to 5,000 feet, and peaks rising out of the snow to 6,000 and 7,000 feet. Indeed, the highest peak is 8,400 feet. These peaks are the steep heights that have not been covered by the ice cap which wears down the shoulders of the range.

The range divides into two as it goes southward, the chief branch following the Norwegian coast, and the other continuing to form the "Keel" boundary between the two countries as it sinks in height.



Norwegian Official photo

Norway's rushing streams give much hydroelectric power. This is Vammafoss power plant on the Glomma River.

So, while Norway and Sweden look away from each other down the short and steep Norwegian slope, and the long and gradual Swedish slope, at the top they halve the line of peaks and plateaus.

The area of Norway is 124,556 square miles. Much of it is mountain land, not good for cultivation except in patches. It has a population of around 3,000,000. The Norwegians make the fullest use of their abundant forest lands, the fishing of their tumbling mountain streams, and the grazing of their Alpine pastures as the snows retreat; but they are a seafaring people, as they have been for a thousand years and more. The sea fisheries of Norway are of great importance.

Ewing Galloway

An exact copy of a medieval wooden church, which stands in the grounds of the Norwegian Folk Museum in the city of Oslo.

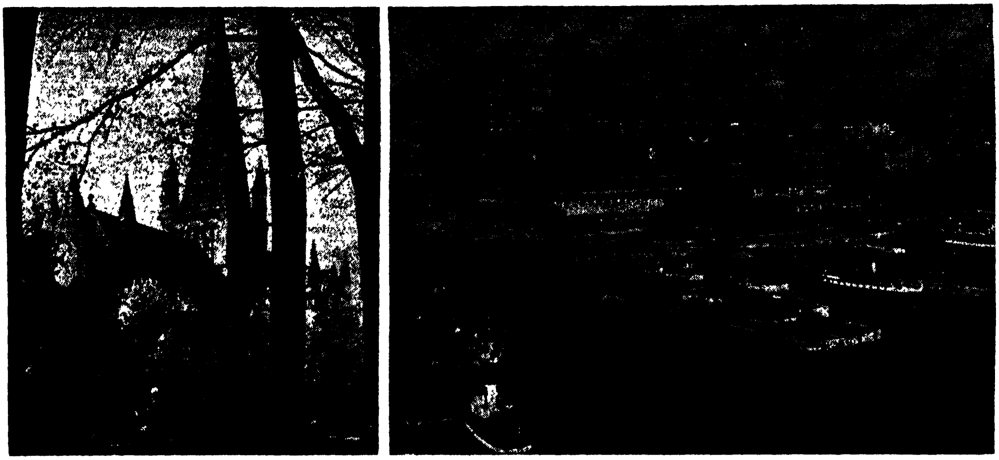
Before the second World War, the tonnage of Norwegian merchant shipping ranked fourth among the seafaring nations, though Norway had the smallest population of them all. The order was: Great Britain, the United States, Japan, Norway, Germany, Italy and Holland. Norway's commercial fleet was larger than that of France, though France had fifteen times her population. It surpassed that of Holland, though Holland had the trade of great colonies; and it was several times that of Spain. Now, of course, the shipping of Germany, Japan and Italy has been much reduced; and that of the United States has been vastly increased. Norway has small stores of many important minerals, and quantities of iron ores. She has no coal or oil, but abundant water power from the swift streams that pour down the slopes. "White coal" is the name we sometimes give to the power of falling water which can be used to create electric current.

Norway's exports include wood pulp, ships, paving material and matches.

Many visitors are attracted by the stern beauty of the fiords. The chief fiords, as we go from the south toward the north, are Christiania Fiord, leading from the Skagerrak up to the capital city, Oslo; the Bukken Fiord, near Stavanger, leading up to Sand; the Hardanger Fiord, leading to Odde. Then, north of Bergen, the Sogne Fiord to Gudvangen; the Nord Fiord to

Norwegian Official photo

One of Norway's famous fiords, narrow arms of the sea that wind in and out among steep, wooded mountains.

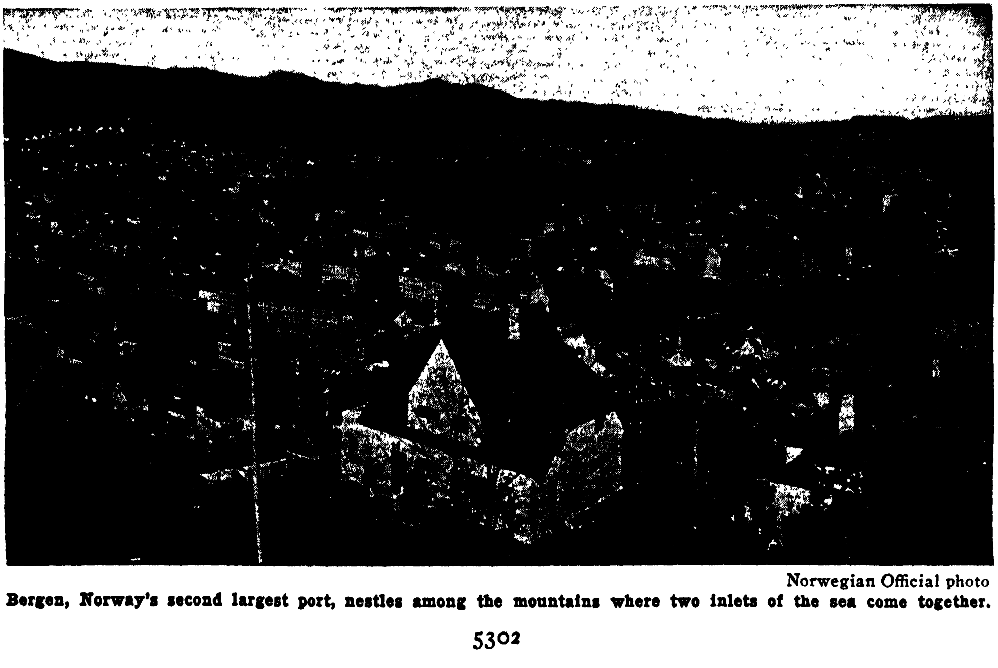


Norwegian Official photo

Two Norwegian cities. Left, the cathedral at Trondheim; right, Oslo, the capital, with its modern Town Hall.

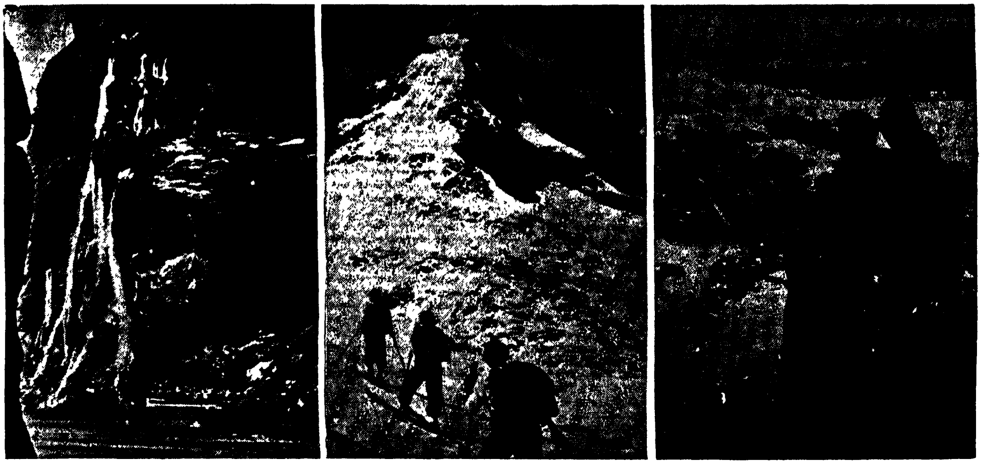
Loen; the Stor Fiord to Marok; the Molde Fiord to the Romsdal; and Trondheim Fiord to Trondheim. On some tours the people steam inland, sometimes one hundred miles, to the head of a fiord, and then leave the ship and ride by pony and cariole, or walk, to the head of the next fiord, where they are met by the ship which has threaded its way to sea and ascended the neighboring fiord. The overland journey from fiord to fiord usually takes two days. In this way visitors see something of the country inland as well as along the coasts.

Blue-eyed, yellow-haired, tall and well-proportioned, the Norwegians are pleasant to the eye, and their frank speech and honest ways are backed by genuine kindness. No people are kinder to animals than the Norwegians and the Swedes, and the wild creatures know it. Birds are tamer there than in other lands. As for the fawn-colored ponies that draw the little vehicles called



Norwegian Official photo

Bergen, Norway's second largest port, nestles among the mountains where two inlets of the sea come together.



Norwegian Official photo

A transatlantic liner cruising through a fiord; followers of the ski-trails; a Norwegian fishing village.

carioles, they are so petted that they become mischievous in the quiet way of the country, and will play the traveler harmless pranks.

Norway is a very beautiful country, though rugged and thinly covered with soil. Its scattered people work hard on their patches of grassland and grainland, in their forests, at their fisheries and in their small ships at sea, and they are willing to work. The fierceness of their Viking ancestors is no longer to be seen, but the old adventurousness is left. They still roam about the world. Many emigrate, and return with money saved. Their seamen are bold and resourceful. It was a Norwegian, Amundsen, who first reached the South Pole; and Dr. Fridtjof Nansen (1861-1930) excelled as a daring traveler in the far north.

The Norwegians live in a scattered way, but they educate their children well. Their only large city is Oslo (once called Christiania), the finely placed capital. It is a comparatively new city, and modern in every way, with over a quarter of a million inhabitants. Bergen, with nearly 100,000 people, is the second center of shipping and business. Other ports are Stavanger, in the south, and the ancient capital Trondheim, a great center of the fishing industry.

Farther north, opposite the rugged Lofoten Islands, a railway runs from Narvik to Finland and Russia, passing the iron mines of Lapland. It proved an invaluable line of communication during World War I, and played an important part also in World War II, after Germany conquered Norway. Tromsö, still farther north, is the Norwegian outpost for Arctic sailing. Here the mountains have lessened in height and the scenery begins to have a depressing effect from its barrenness. In normal times many tourists visit North Cape, where in the latter half of June the sun may be seen shining brightly at midnight.

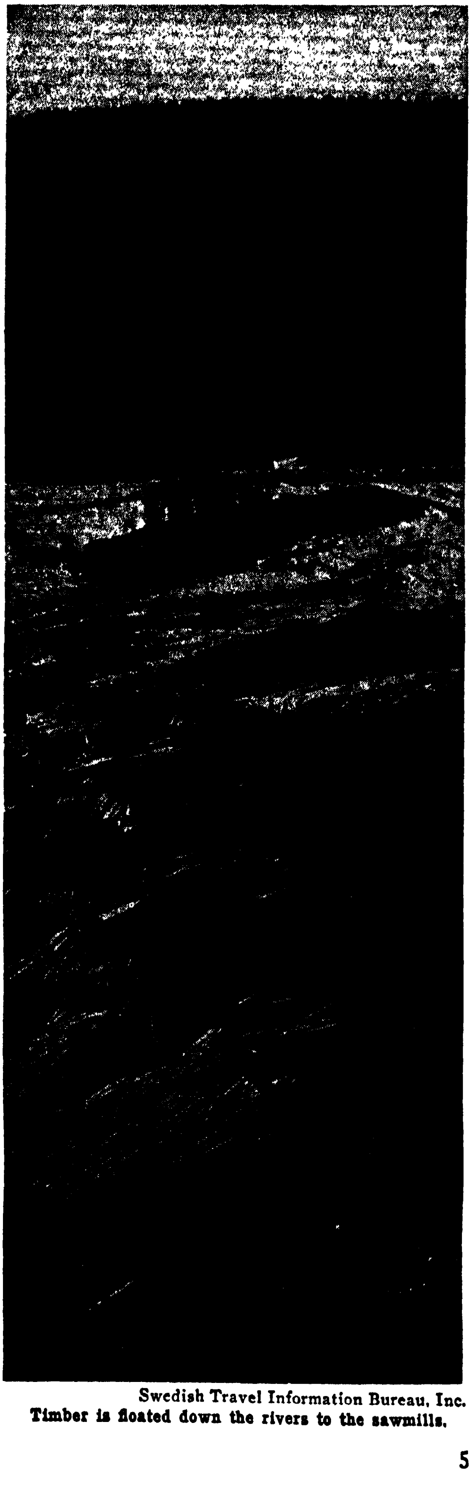
Norway's government is a constitutional monarchy. From 1940, when the country was overrun by German troops, until 1945, when Germany was beaten, Norway's king and ministers carried on a government-in-exile, in London.

SWEDEN AND ITS PEOPLE

Sweden, the largest and most populous of the Scandinavian nations, differs from both Norway and Denmark in having abundant mineral resources of fine quality.

It resembles Denmark in its successful agriculture in the south, and Norway in its fine forest lands, which make its export of timber, wood pulp and paper important, but its mineral products give it a distinction entirely its own.

The central part of the country is extremely rich in iron of exceptional purity. It has also zinc, manganese, sulfur, and some copper, silver and lead. If Sweden had an



Swedish Travel Information Bureau, Inc.

Timber is floated down the rivers to the sawmills.

ample supply of coal or oil it could be one of the leading manufacturing countries in the world. As it is, charcoal has to be used largely in the smelting of its metals. Notwithstanding the lack of coal and oil, its exports of metal goods and machinery rank next in value to its timber and such timber products as wood pulp.

SWEDEN HAS MANY LAKES AND WATERWAYS

Sweden has an area of 173,403 square miles, and a population of 6,523,000. The land has a general southeasterly slope to the Baltic from the wide mountain range which separates it from Norway. It possesses an abundance of navigable inland waters, especially lakes. The great lakes Wener and Wetter in south central Sweden, and Lake Mälar near Stockholm, with many smaller lakes, are joined together by a canalized water system extending to more than seven hundred miles, and the country has a convenient network of railways.

The northern part of Sweden, in common with a small part of Norway and the northern extension of Finland, is inhabited by a stock that is not Nordic—the Laplanders. The Lapps were driven northward by the Nordic invaders in a period beyond history, but probably most of them have lived from time immemorial on the snowy plains of the north, in close association with the reindeer which there finds its natural home. There they maintain a civilization which is entirely their own, and which illustrates the life of man in ages generally studied through geology.

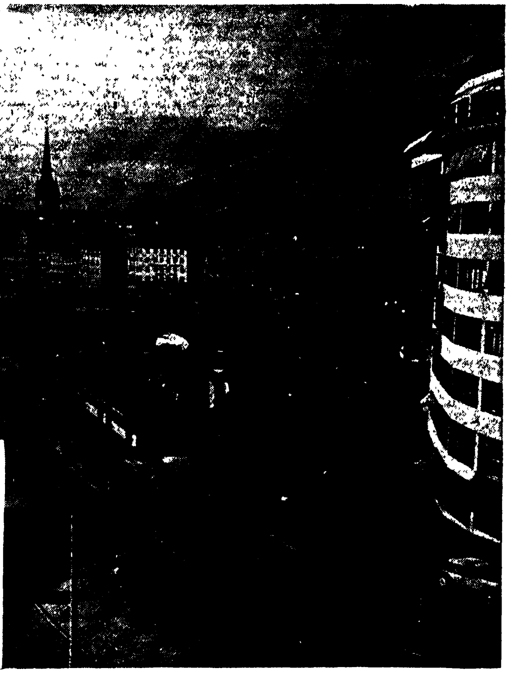
THE STRANGE INHABITANTS OF LAPLAND

In Sweden and Finland the Lapps are usually divided into fisher, mountain and forest Lapps. In Norway there are sea Lapps, river Lapps and mountain Lapps. The mountain and forest Lapps are the real Lapps. They are nomadic. In the autumn the mountain Lapp builds his wooden storehouse on the edge of the forest, and during the winter he wanders south. About the middle of May he is back at his storehouse, but as soon as the weather grows warm he pushes up to the mountains, and there through the summer pastures his herds and prepares his cheeses. By October he is busy at his hut, killing his surplus reindeer and curing meat.

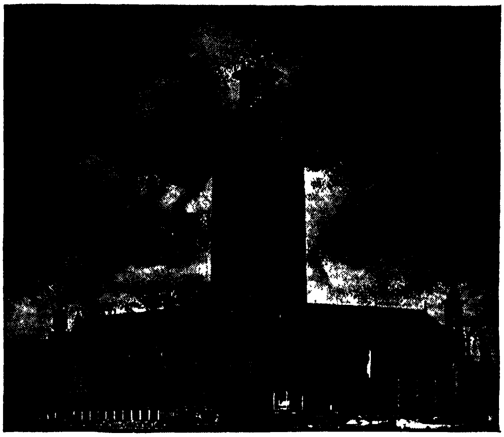
The life of the forest Lapp is similar, save that he never wanders out of a certain district where he has hereditary rights. In

THE VENICE OF THE NORTH

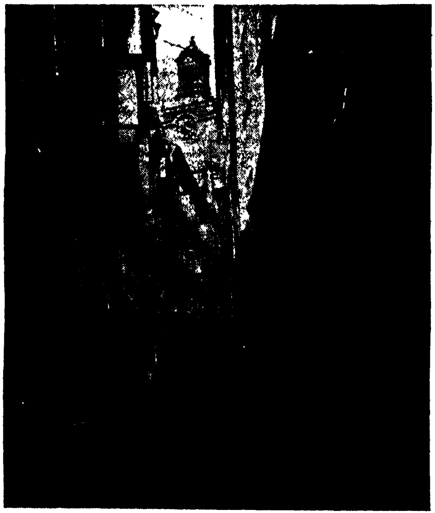
The statue of Sweden's hero-king, Charles XII, in Stockholm.



Stockholm is built on a group of islands and is crisscrossed by many waterways. This picture shows a view of the quaint stepped gables and spires of the old part of the city from the higher land of the more modern section.

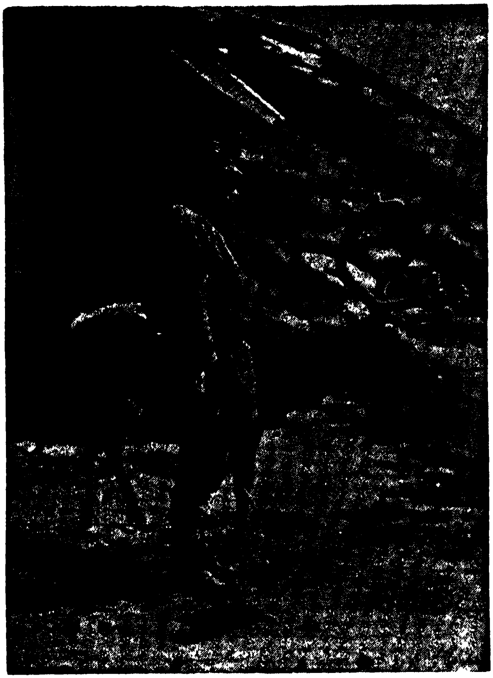


Stockholm's famous Town Hall, with its colonnaded terrace and its bell-tower, seems to rise out of the water like a Venetian palace from its lagoon. This has been called "the most remarkable building since the Renaissance."



Photos, Swedish Travel Information Bureau, Inc.

New and old in Stockholm. A modern playground contrasted with a narrow, dingy lane in the older part of the city.



Swedish Travel Information Bureau, Inc.

The Lapland reindeer is a sturdy, useful animal.

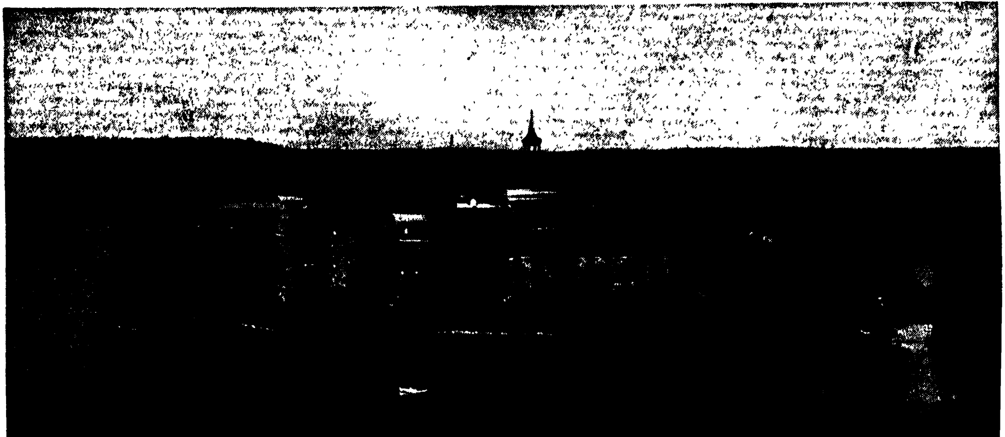
spring he lets his reindeer loose, and after midsummer, when the mosquitoes grow troublesome, collects his animals till August, when they are again let loose until October.

Stockholm, the Swedish capital, is one of the most beautifully situated cities in the world. It is built on a number of islands, at the strait where Lake Mälar joins an arm of the Baltic. It is often called the Venice of the North, but many travelers regard it as far lovelier than the Italian city. There are fine buildings going back to the seventeenth and eighteenth centuries, as well as modern structures. The city contains one of the most complete historical museums ever devised. If a Swedish novelist wishes to write a Swedish story of any period, in any part of the country, he can find in the museum rooms, furnishings and costumes illustrating the lives of the people in that time and place. Stockholm has a population of 634,000.

The other seaports of Sweden are Göteborg (Gothenburg), the front door of the country, connected with the central parts by canal as well as rail; Malmö, opposite Copenhagen on the Sound; Norrköping on the Baltic, south of Stockholm; and Karlskrona, on the southern Baltic. The port of Wisby, on the island of Gotland, has played a prominent part in Swedish history. The most interesting historical town is Uppsala, the ancient capital, which has the leading university. Lund, the other university, is in the extreme south.

The Swedes, like the Danes and Norwegians, are among the best-educated people in Europe. Many of them speak several languages, including English. Like their Nordic neighbors, they are also extremely democratic in feeling, and almost exclusively Protestants of the Lutheran denomination.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 5494.



Swedish State Railways

Beautiful and historic, Gripsholm Castle's four red towers look down upon their reflection in the clear waters of the Mälar. The castle was built in the sixteenth century and many Swedish kings have lived there.

A cocoon is the wonderful little house of silk which the silkworm spins. Here are cocoons being packed and stored.

THE WONDER *of a* PIECE *of* SILK

THE sources of the four most important natural textiles used in the world today are wool from the backs of sheep, cotton and linen from plants and silk from the cocoon spun by a certain caterpillar, the *Bombyx mori*. Though we call this the silkworm, it is not really a worm, but a moth.

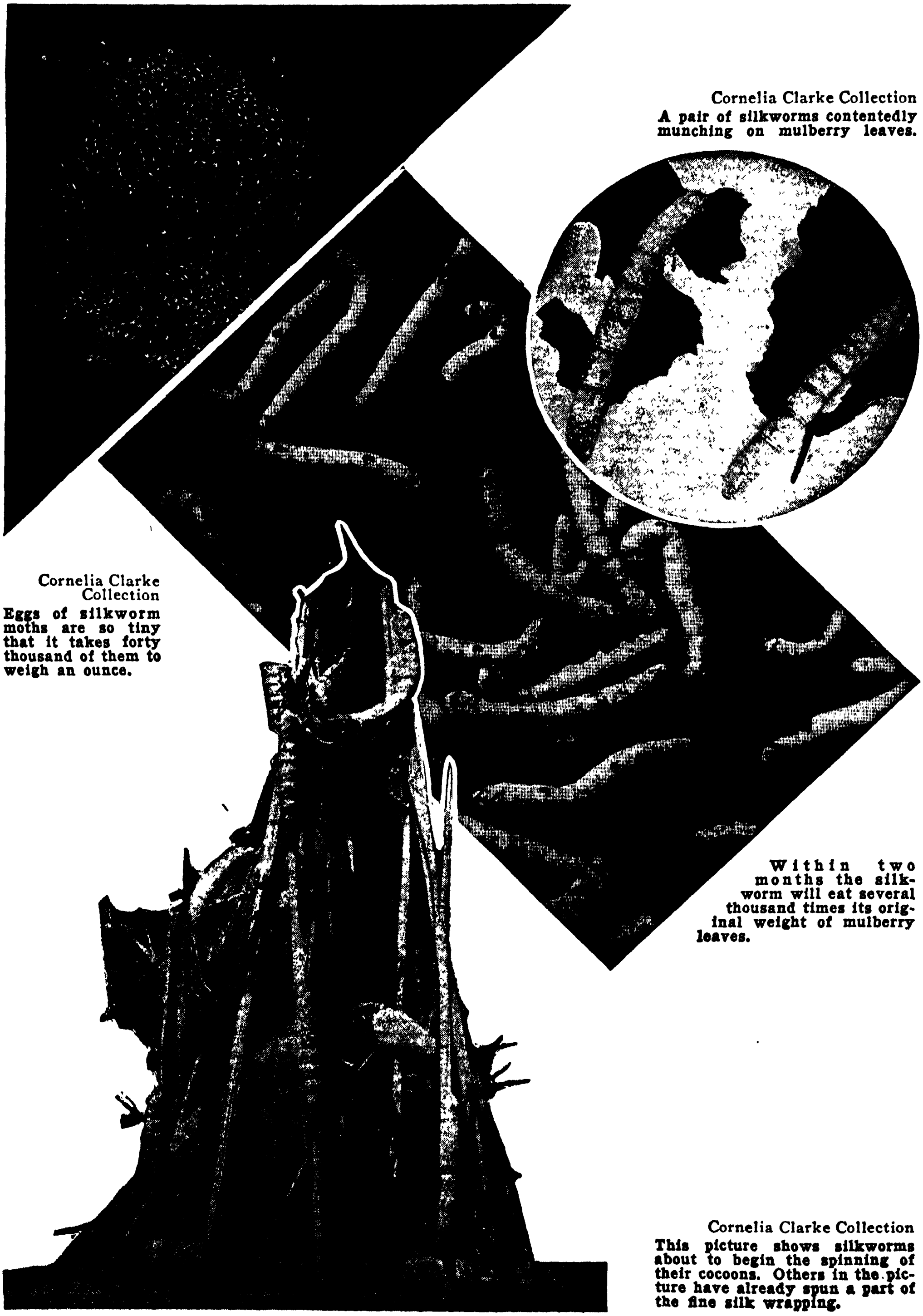
The article on Butterflies and Moths tells us that these little creatures live their lives in four chapters. First there is an egg. The egg hatches, and out come a grub, or caterpillar, or larva, looking somewhat like a little worm. This eats and grows and bursts out of its skin, and eats and grows and bursts out of its skin several more times. Then comes the third chapter of its life. The caterpillar spins a long slender thread, miles of it, and winds the thread round and round its body, until it is completely covered; and in this silken nest it goes to sleep. The nest is called a cocoon. Inside the cocoon the caterpillar changes into a butterfly or into a moth, which breaks out of the cocoon to spend the last chapter of its life as a winged creature.

The silk which we use is the slender thread unwound from the cocoon of the *Bombyx mori,* while the caterpillar is still asleep within the nest.

It was those wonderful people the Chinese who first discovered the use of silk. They learned that it could be woven into material, and they learned how to get it from the silkworm. They found that the silkworm could be kept alive in captivity; that it would thrive as a prisoner if it were kept clean and were fed on mulberry leaves. So they kept the caterpillars, and when these turned into moths, they kept the eggs the moths laid. When the new generation of caterpillars spun cocoons of silk the Chinese took a certain number of the cocoons and unwound the silk of which they were composed, and made the silk into cloth.

What the Chinese were doing with caterpillars nearly five thousand years ago, the people in many countries are doing today,

THE SILKWORM FROM EGG TO COCOON



Cornelia Clarke Collection
Eggs of silkworm moths are so tiny that it takes forty thousand of them to weigh an ounce.

Cornelia Clarke Collection
A pair of silkworms contentedly munching on mulberry leaves.

Within two months the silkworm will eat several thousand times its original weight of mulberry leaves.

Cornelia Clarke Collection
This picture shows silkworms about to begin the spinning of their cocoons. Others in the picture have already spun a part of the fine silk wrapping.

and all for the same purpose, that men and women may have silk to wear or to use for the thousand and one purposes for which this beautiful fabric is so much sought.

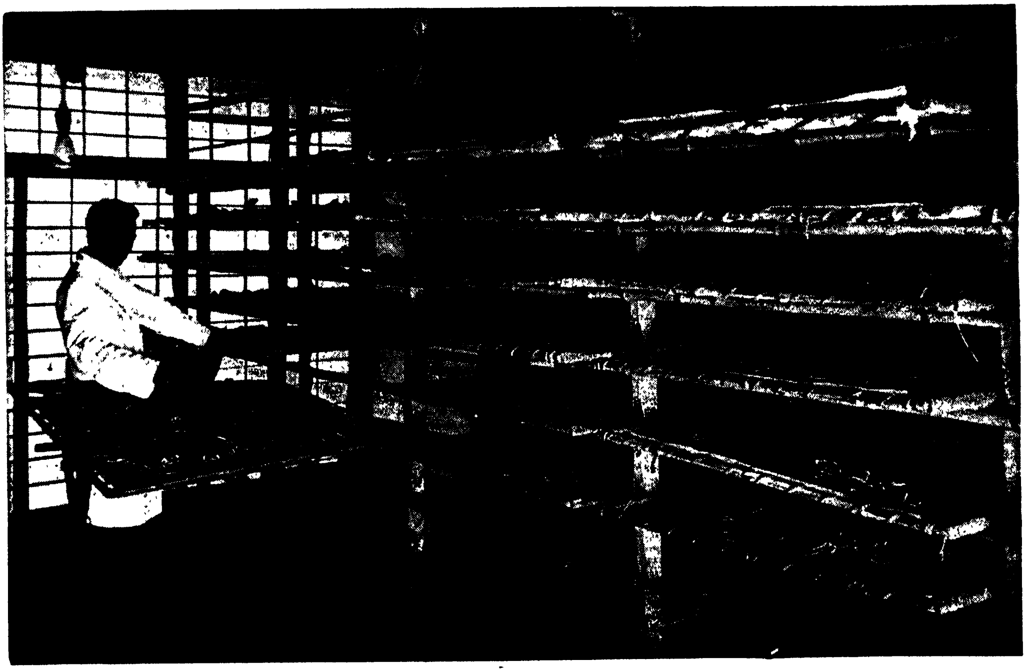
It is very wonderful to think that all the millions of silkworms that for many years produced the silk upon which the whole of Europe mainly depended came from a single batch of eggs brought by two monks from China.

This is the story. The art of making silk began, as we have seen, in China. The Chinese guarded their secret as closely as they could. They did not want people in other countries to know how to make silk. If other people wanted silk, they must buy it from the Chinese, not make it for themselves. They sold a good deal to Rome, for Rome in all her glory could not produce silk for herself.

This state of things lasted until 550 years after the birth of Christ. Then the wise emperor Justinian, who ruled in Constantinople, saw how important was the silk trade, and determined that he would create it in the Roman Empire. Two Persian monks who had long lived in China told him that they had seen the whole process of rearing the silkworms and the manner of treating the silk. So Justinian sent them secretly to China to get some eggs of the silk-moth. They walked all the way from Constantinople to China, and they walked back again, bringing with them some of the precious eggs.

It would have cost them their lives had the purpose of their visit been known. They knew this and were very careful. They got a supply of eggs of the silk-moth, hid them in a hollow bamboo, and then carried them to Constantinople and there presented them to the Roman emperor. The Emperor was delighted. The eggs were hatched, and there appeared, for the first time in history, a number of captive silkworms in Europe. From each female moth he got five hundred or more silkworms, and from these, in turn, another great increase. The monks had brought him, in a little bamboo nest of eggs, a rich gold mine.

The Emperor caused a silk factory to be set up in his palace. Only those whom he appointed were allowed to manufacture silk. But in the course of time the eggs of the silk-moths were carried to other countries.



The silkworms must be carefully tended and provided for during the time of growth after they have been hatched from the eggs. They are kept in a dry, cool place, on trays—as we see here—and are fed with mulberry leaves until the time when they are ready to begin the spinning of the silken cocoon. The Chinese people learned how to produce silk in this way nearly five thousand years ago. For a long time the art was kept a secret.

THE HOUSE THAT THE SILKWORM SPINS

How the cocoons look after they have been spun among the branches of a bush. Here the silkworms have enough space to move, while wrapping the silken strands around and around.

Cornelia Clarke Collection

Among thick branches, the fibers of silk catch and spread into a web, while the cocoons are being spun. Silk is thus wasted. Compare this with the picture at the top of the page.

From the cocoon there comes forth, not the silkworm, but a silkworm moth. This change from worm to moth is called in science metamorphosis.

A cocoon, with caterpillar inside, has been cut open. When the worm has changed into a moth it makes a hole at one end of the cocoon and comes out.

In Italy and France many towns became famous for their silk manufactures. Frenchmen took the secret of manufacturing silk to England, where an important industry quickly grew up. Men tried hard to cultivate silkworms in England and in Germany, but never succeeded sufficiently to supply the factories with cocoons.

Before the American colonies became independent, mulberry trees were imported, and attempts were made to grow silkworms, but with little success. Though the mulberry grows well and the worms thrive, the process demands much labor and constant watchfulness. Labor has been too scarce and wages have been too high to permit the industry to become profitable in the United States. At present renewed efforts are being made in California, and some raw silk is being produced.

About the year 1850 a terrible disease broke out among the silkworms of Italy and France. In spite of the disease there were always some healthy caterpillars producing silk, and the trade never came to a standstill; but the damage done robbed France and Italy of hundreds of millions of dollars.

It was only then that Europe had to send again to the East for more eggs of the silkmoth. For hundreds of years Europe had been stocked with its millions of silkworms from the descendants of those silkworms which came from the eggs carried away in a little bamboo by the two monks at the command of Emperor Justinian.

Raising silkworms is not particularly difficult. Any boy or girl in whose yard a mulberry grows can raise silkworms if he or she can get the eggs and is willing to take the trouble. Many boys and girls have done precisely what is being done in Japan and China or in southern Europe. Let us see how it is done. The pictures tell almost the whole story.

The moths are encouraged to lay their eggs on sheets of paper. These eggs are very tiny—it takes forty thousand to weigh an ounce—and must be kept in a cool, dry place until the mulberry trees are in leaf. Then the eggs are placed either in the sun or in an incubator, where they soon hatch. The tiny larvae begin to eat at once and grow rapidly. Within two months they melt, or change their skin, four times and eat several thou-

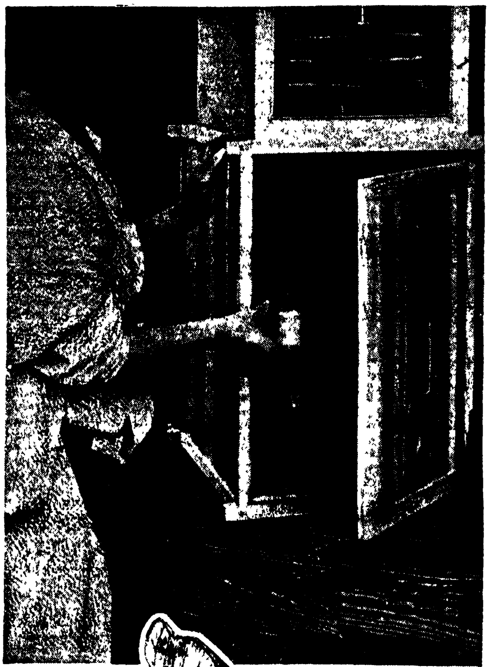
Before World War II, the Japanese were great producers of silk. Here we see Japanese workmen testing the silk on the cocoons. Sample cocoons are picked out and their silk is tested for its strength and ability to stretch.

sand times their original weight of mulberry leaves.

The caterpillar is now about three inches long and eats vigorously for a few days more. Then it prepares for its end. All the time that the silkworm has been growing up, it has been forming and filling two large vessels, or sacs, that run along the sides of its body. In these two sacs is stored a sticky fluid.

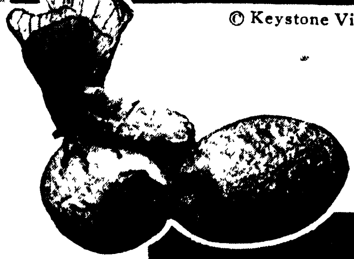
That sticky stuff in the body of the caterpillar is to become the marvelous silk which makes the insect so valuable. When it is about to spin, as we call it, the caterpillar ceases to eat. As we watch we see a tiny stream issue from its lower lip. That is the silk issuing from the spinnerets, or seripositors. The sticky fluid, if we force it from the body of the silkworm, becomes hard at once; but manipulated by the silkworm it is drawn out into a beautiful fine strand of silk. Strands from two sacs are joined together by the silkworm to form one thread, and it is only by the aid of the microscope that we are able to discover that there are two in the thread. With this material the silkworm weaves its lovely house of silk.

The work usually takes three days, but may take four, or even five. All the time that it is building, the silkworm works its head round and round in regular order, never wearying. And all the time the silk never fails. Little by little the silkworm builds up its castle, weaving it so perfectly that at last the caterpillar is entirely enclosed in it.



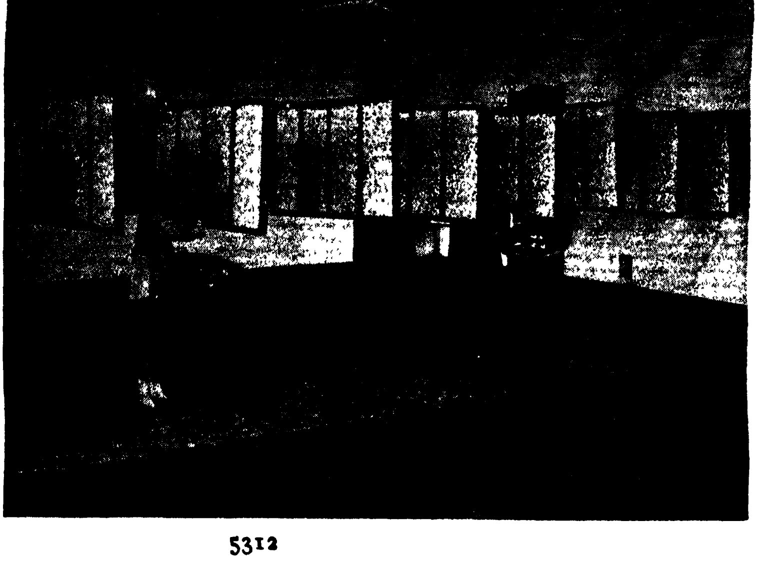
© Keystone View

Silkworm eggs may be hatched in the sun, or in an incubator (as here), where the heat is carefully regulated.



Ewing Galloway

Above, at right, is a silkworm moth and two of the empty cocoons.



Ewing Galloway

Here are silk workers in China. They collect the moths as they come from the cocoons, and use them to hatch eggs for a new supply of silkworms.

The silkworm, at the beginning of the task, weighs over 90 grains. When the labor is ended, the silkworm, with its cocoon, weighs only about 50 grains. And there it is in a lovely globe of tightly woven silk, looking like some fairy pigeon's egg. The cocoon may be either white or pale yellow. Having watched the spinning, we realize why the silkworms must have plenty of space. If they are at all cramped, two will spin together only one cocoon, and this will be less valuable.

If the cocoons are left undisturbed, there will come forth, in from fifteen days to three weeks, a moth from each. The average length of the moths is about half an inch. The males are slightly smaller than the females. The moths can be kept on a cloth. They eat very little, and sometimes even nothing at all. They mate as birds mate. The females lay five hundred or more eggs and then die, and the males do not live long after them. Their whole lives as moths last but a few days. In that time they never try to fly away. The females can not fly at all; the males have just enough power in their wings to steady themselves in descending, but they can not possibly fly upward.

In this we see the result of thousands of years of care and attention on the part of man. The *Bombyx mori* has always been the one species common everywhere as man's silk-producer; there are others in captivity in China and Japan, but they are not of very much importance. The *Bombyx yama-*

Sorting cocoons by passing a light under them. Dark spots show defects.

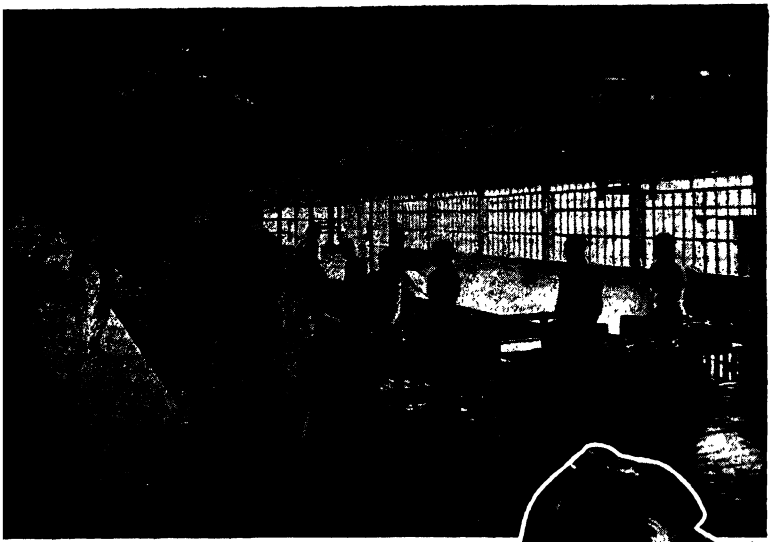
Ewing Galloway

Spinning rods filled with cocoons, as used at Lingnan University in Canton, China.

Ewing Galloway

Pupils at Lingnan University inspecting silkworm moths with a microscope for egg production.

STEPS IN THE MAKING OF RAW SILK



Steaming cocoons to kill the chrysalids inside. This is done so that the moths will not break the strands of silk in forcing their way out. A chrysalis is a "sleeping" caterpillar before it changes into a moth.

This woman is joining the slender silk fibers length-wise, to make a thread for weaving.

One step in the manufacture of raw silk — winding the fiber on wheels. In China and Japan women do much of the work in the silk factories.

mai, the silkworm of Japan, which eats oak leaves, furnishes excellent silk; and there are many other kinds of silkworms that furnish a little. Those that have been allowed to remain wild can fly about as well as any other moths. Only those that have been cared for by man have lost the power to fly. If they could fly, they would fly away, and we should never know where to look for their silk.

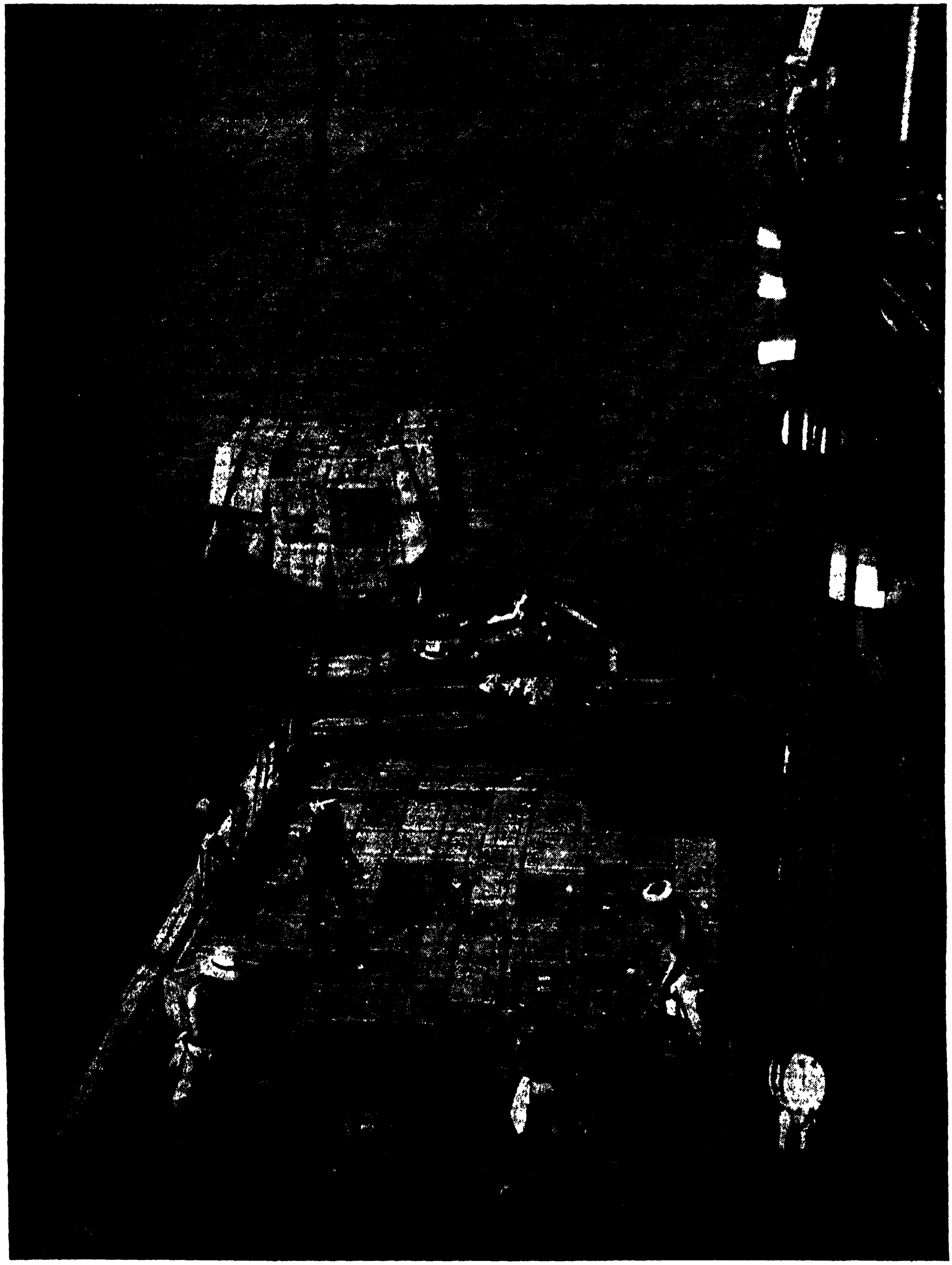
This Japanese loom for weaving silk fabric is quite a large one, and it requires two men instead of the usual one. A loom of this type is a machine, in that the workers have no control over the design. At the lower part of the picture we see the finished weave, with its striped and flowered pattern. Machine looms have helped to improve the quality of silk weaving, and to increase the production, thus providing more silk at a lower cost.

So far we have traced the silkworm from the egg to the caterpillar to the moth. What of the silk, of which we have talked so much? Here we come face to face with a little tragedy, for every silk dress that is made means the death of thousands of silkworms. The life of the silkworm is ended when the insect has reached the chrysalis, or cocoon, stage. It is then in a state of torpor and can have no sense of feeling. When the cocoons are all ready it is decided how many moths are needed to renew the supplies of eggs. Some of the best cocoons are taken for the nursery. The others are wanted for silk.

The reelers then steam them, plunge them into boiling water, or submit them to a high dry heat. This kills the chrysalis. The reason why this has to be done is that, if life remained in the chrysalis, the latter would turn into a moth, and would then form an opening at one end of the cocoon out of which to creep, thus spoiling the cocoon for man's purposes.

The next step is to wind the silk on the reels. To do this the cocoon has first to be softened in water which is warm but not hot. The water dissolves the gum that binds the silk together. A girl with skillful hands then twirls the cocoons about with a light brush that catches the loose ends and causes them gradually to unwind. All that we have to do is undo the work that the caterpillar did. But the silk so far is too fine to be wound in this state. In the thinnest part the silk is so

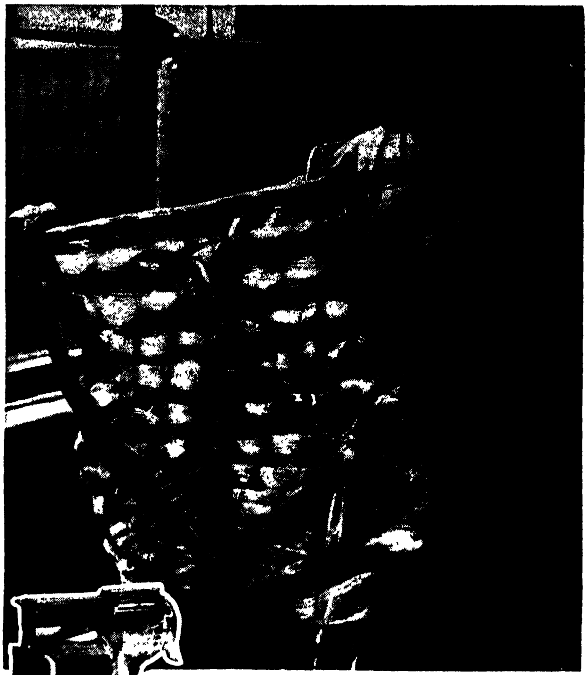
LOADING RAW SILK FOR SHIPMENT



Ewing Galloway

The silk trade has been a wonderful chapter in the world's history since the early days of the silk caravans from Asia to Europe. Marco Polo brought word of the rich and beautiful silks in the Far East, and Columbus hoped to discover a direct route and bring back these treasures to Europe. Modern ships bear the silk cargoes of today.

REELING AND JOINING STRANDS OF SILK



A skein of fine, shimmering silk. The threads are interwoven in darning pattern to prevent tangling in the next step—winding on reels.

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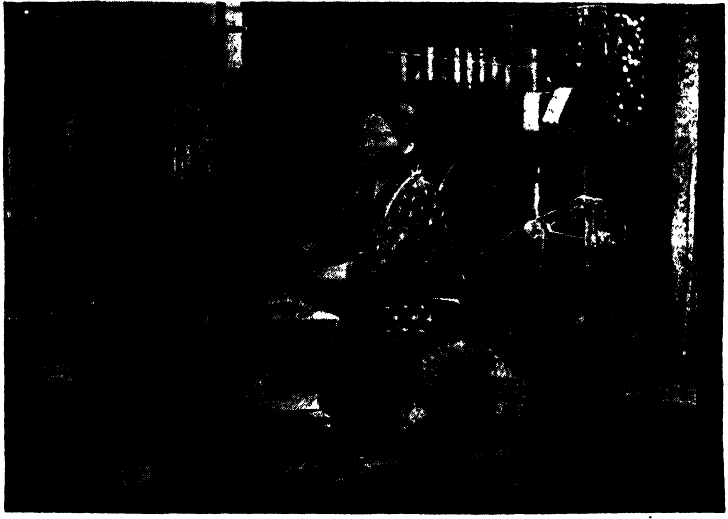
This man (in America) is using a machine to join fibers together. This is the operation that is being done by hand by the Japanese woman pictured on page 5314.

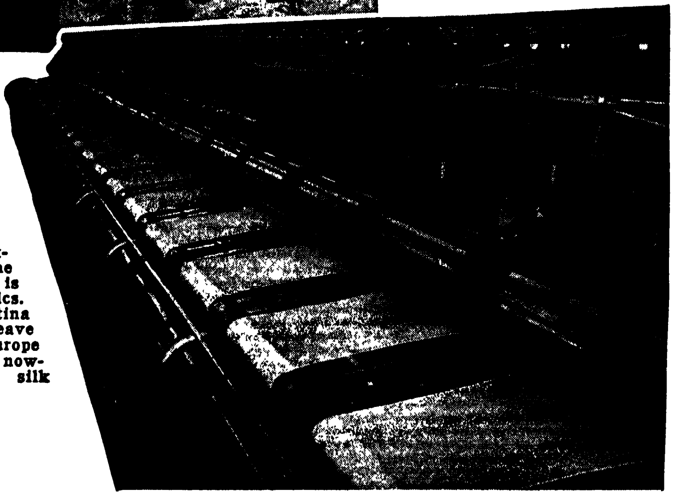


American Museum of Natural History

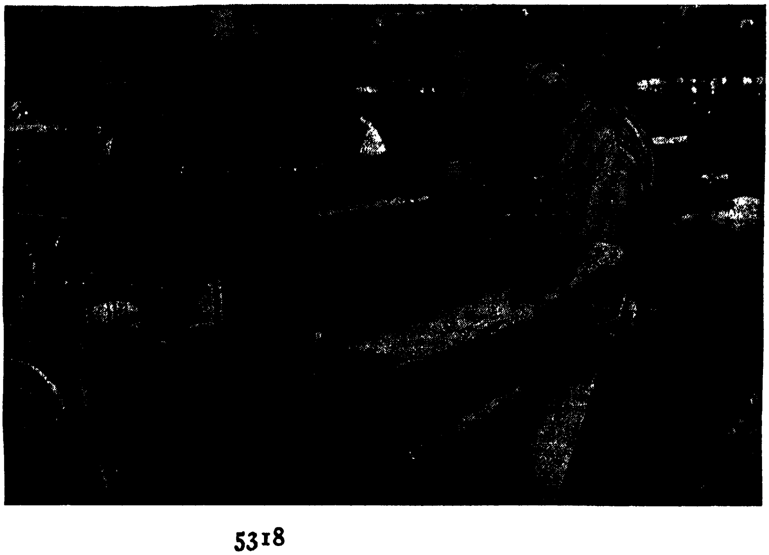
This Japanese woman is unwinding the strands of silk from cocoons and winding them upon reels. The wheel, driven by a foot pedal, keeps the reels turning.

HOW SILK HOSIERY IS KNITTED

Before the final steps of dyeing, printing and finishing, the silk must be thoroughly washed, and sometimes bleached.



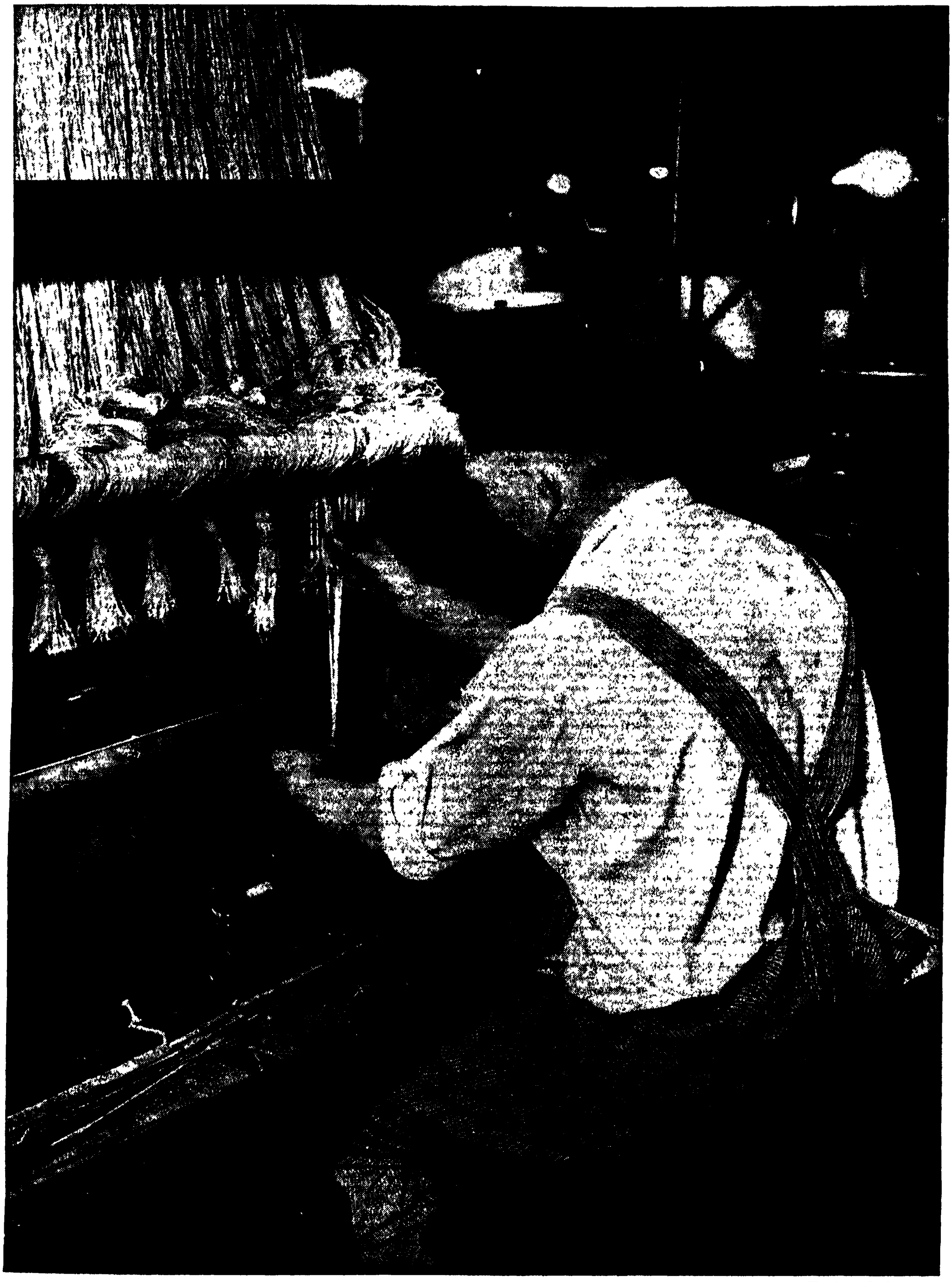
Scenes in a modern silk-weaving factory in the United States. France is noted for fine silk fabrics. Italy, Switzerland, Argentina and Great Britain also weave silk. Once Southern Europe produced much raw silk, nowadays most of the raw silk comes from Asia.



All pictures on this page from Ewing Galloway

Though enormous quantities of rayon are made yearly, silk is still highly prized. Plain and printed weaves, satins, brocades, velvets and ribbons and laces find eager markets.

THIS LOOM WEAVES PATTERNS IN SILK



Ewing Galloway

A wonderful machine is this Jacquard loom, which weaves patterns in the silk. This is done by a method similar to that used in a player-piano. Pattern cards, with holes punched in them in the form of the design, allow needles to pass through and work the pattern into the fabric. The loom was named for Joseph M. Jacquard, its inventor.

fine that two thousand strands of it laid side by side may cover only an inch, while in the thickest part from six hundred to seven hundred would be required to make up an inch in thickness.

HOW THE SLENDER STRANDS OF SILK ARE UNWOUND FROM THE COCOONS

So, when the ends of the silk are discovered, the operator joins the filament from several cocoons together, passes them through a fine eye of glass or polished metal in a winding machine, and letting the coccoons remain in the water, winds away until all the silk that can be used is wound out from each coccoon. As one cocoon is exhausted another is added, so that there is no limit to the length of the filament. The silk is wound on a wheel, or a reel, and care must be taken to see that the strands do not stick together. In Eastern countries and in some parts of Europe, machinery so simple that a boy could make it is used; but in big factories they have much improved on this. Still, the principle is everywhere the same.

Once the silk is freed from the cocoon and wound on reels, it is made into hanks, or skeins, and is ready for the manufacturer. Many processes follow. The silk has to be freed from all the gum remaining on it, for at present it has no luster such as we expect silk to show. It has to be cleansed by boiling, to be scoured, and purified by acids. That is one way. Another is to let the silk begin its own purification by a process of fermentation, which is done by shutting up the uncleansed silk in tanks containing soapy water, in which it may lie for weeks. Then follow all sorts of washings, and finally a drying.

THE METHOD OF WEAVING MAY PRODUCE PLAIN SILK, OR SATINS, OR VELVETS

The silk may be woven just as it comes from the cleaning machine, or it may be doubled and twisted. Finally the silk is ready to be made up into materials for clothing or furniture or curtains or whatever may be required. A garment of pure silk lasts a very long time, for there are very few things that wear better. Sometimes, however, a silk garment or a silk umbrella becomes full of slits though it has been little used. This trouble usually arises because the dyeing and finishing have not been properly done.

So far we have described how reeled silk is prepared. As you have seen, silk prepared in this way is a continuous filament, but such silk makes up less than half the weight of the cocoon. The outer layers of the cocoon and the layers next to the chrysalis are not reeled. Then, too, there are double or imperfect cocoons, or those from which the moth has emerged and cut through the threads. Then, too, there are threads broken in reeling. All these are called silk waste, and formerly they were thrown away. Now machinery has been invented which saves this material. After thorough washing, the tangled fibers are straightened, trash and foreign material are removed, and what is left is spun into beautiful silk thread in much the same way as cotton is spun. This spun silk is real, and for some purposes is as good as, or better than, reeled silk. For other purposes it is not so good.

RAYON, A FIBER MADE FROM CELLULOSE, HAS SOME OF THE QUALITIES OF SILK

Many attempts to make thread similar in appearance and quality to that coming from the silkworm have been made, and during the past half century considerable success has been reached. There are several methods, but the general idea is the same in all of them. Cotton, wood, pulp, or other vegetable matter composed chiefly of cellulose, is treated with certain chemicals. The resulting product is forced through tiny holes in the form of fine strands, which, after treatment, may be twisted into yarn, and then may be dyed and woven just as natural silk. The name rayon is generally used for it. We tell you more of all these fabrics in our article on the Wonder of Cellulose.

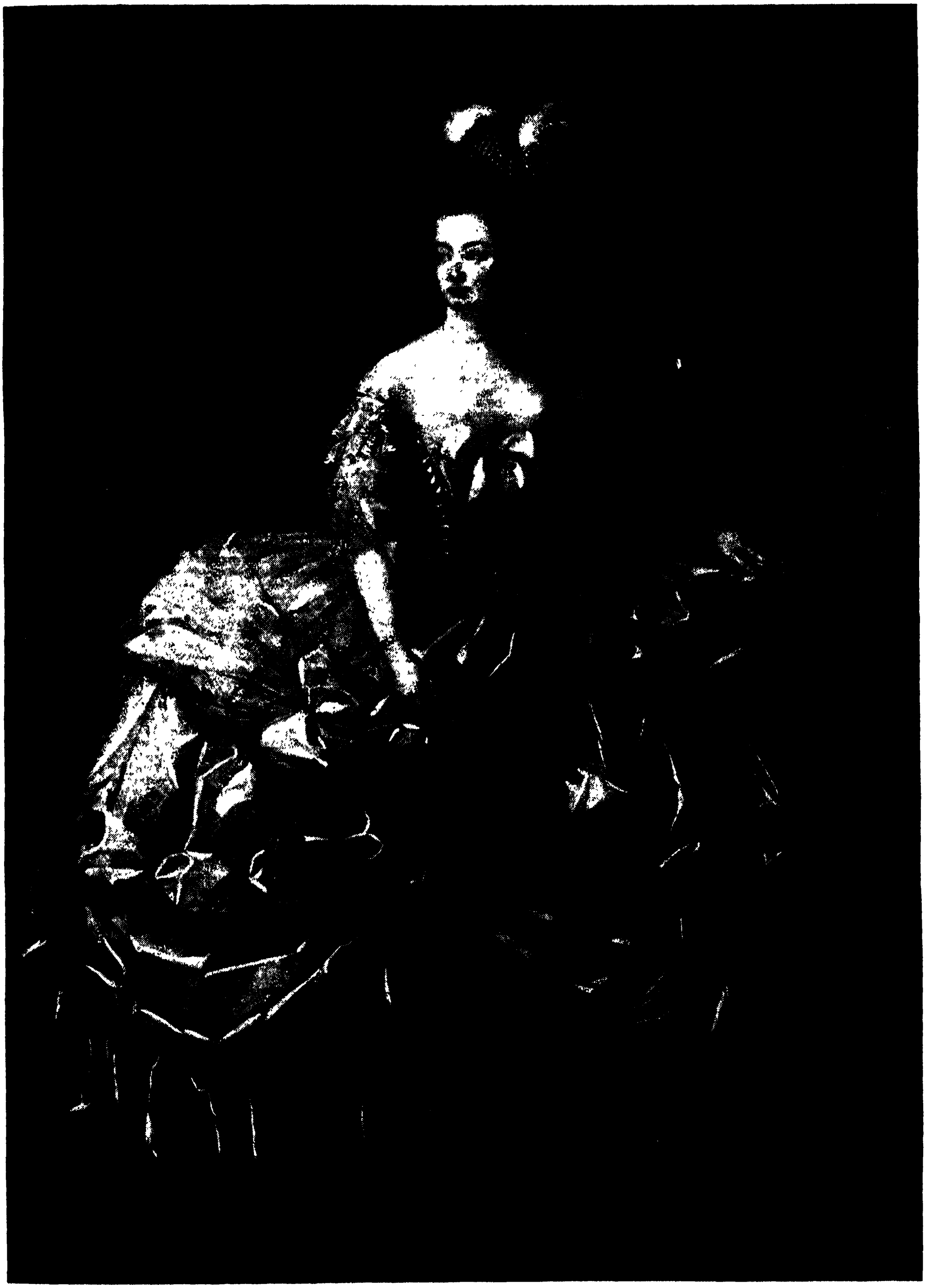
Chemists have continued to seek to make fabrics from other substances. Nylon, made from coal, air and water, is known to you. Stockings made from it are equal to silk in luster and usually wear as well, or better; fabric from nylon yarn is much sought after, for it is easily washed and dries quickly and requires little or no ironing. Vinyon, made from natural gas, salt and water, is said to be stronger than any natural fiber, and to have other good qualities. It is quite possible that silk may soon be little used.

EAST AND WEST SHARE THE WORK OF MAKING SILK

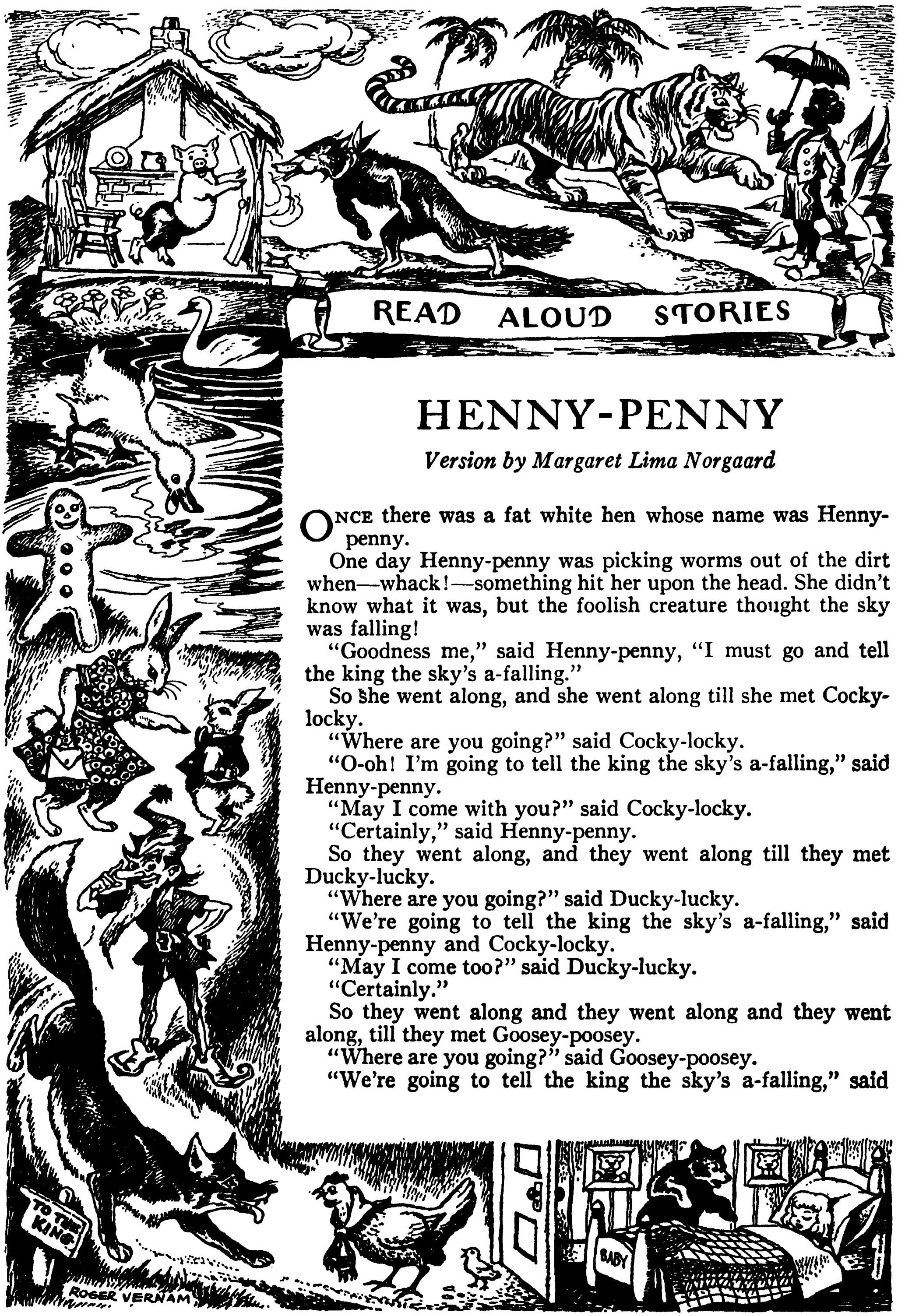
Before World War II, Japan produced about eighty per cent of the world's raw silk. However, most of the weaving was done in the United States, France, Italy and some other countries. Argentina is now also a producer of silk textiles.

Chemists are now experimenting with the problem of making silk directly from ground-up mulberry leaves, without waiting for the silkworm to convert the material.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5330.



Queen Marie Antoinette of France is pictured here in the silken splendor of a royal gown. What a wealth of silk!



HENNY-PENNY

Version by Margaret Lima Norgaard

ONCE there was a fat white hen whose name was Henny-penny.

One day Henny-penny was picking worms out of the dirt when—whack!—something hit her upon the head. She didn't know what it was, but the foolish creature thought the sky was falling!

"Goodness me," said Henny-penny, "I must go and tell the king the sky's a-falling."

So she went along, and she went along till she met Cocky-locky.

"Where are you going?" said Cocky-locky.

"O-oh! I'm going to tell the king the sky's a-falling," said Henny-penny.

"May I come with you?" said Cocky-locky.

"Certainly," said Henny-penny.

So they went along, and they went along till they met Ducky-lucky.

"Where are you going?" said Ducky-lucky.

"We're going to tell the king the sky's a-falling," said Henny-penny and Cocky-locky.

"May I come too?" said Ducky-lucky.

"Certainly."

So they went along and they went along and they went along, till they met Goosey-poosey.

"Where are you going?" said Goosey-poosey.

"We're going to tell the king the sky's a-falling," said

Henny-penny, Cocky-locky and Ducky-lucky.

"May I come with you?" said Goosey-poosey.

"Certainly."

So they went along and they went along and they went along, till they met Turkey-lurkey.

"Where are you going?" said Turkey-lurkey.

"We're going to tell the king the sky's a-falling," said Henny-penny, Cocky-locky, Ducky-lucky and Goosey-poosey.

"May I come with you?" said Turkey-lurkey.

"Certainly."

So they went along and they went along . . . but NOW listen! Whom should they meet but BAD Foxy-woxy.

"Ah, my fine birds, where are you going?" said Foxy-woxy.

"We're going to tell the king the sky's a-falling," said Henny-penny, Cocky-locky, Ducky-lucky, Goosey-poosey and Turkey-lurkey.

"This is not the way to the king," said the sly Foxy-woxy. "I know the proper way. Shall I show you?"

"Certainly."

So they went along and they went along and they went along—till they came to a narrow, dark HOLE.

"This is the way to the king's palace. Follow me!" said Foxy-woxy. He jumped down into the hole, and that foolish Henny-penny, Cocky-locky, Ducky-lucky, Goosey-poosey and Turkey-lurkey followed him.

The fox was waiting there in the dark at the bottom of the hole, and when Henny-penny came down—SNAP . . . SNAP went his sharp teeth as he tried to bite off her head. But it was so dark in the hole that all he got in his mouth was two of her white feathers.

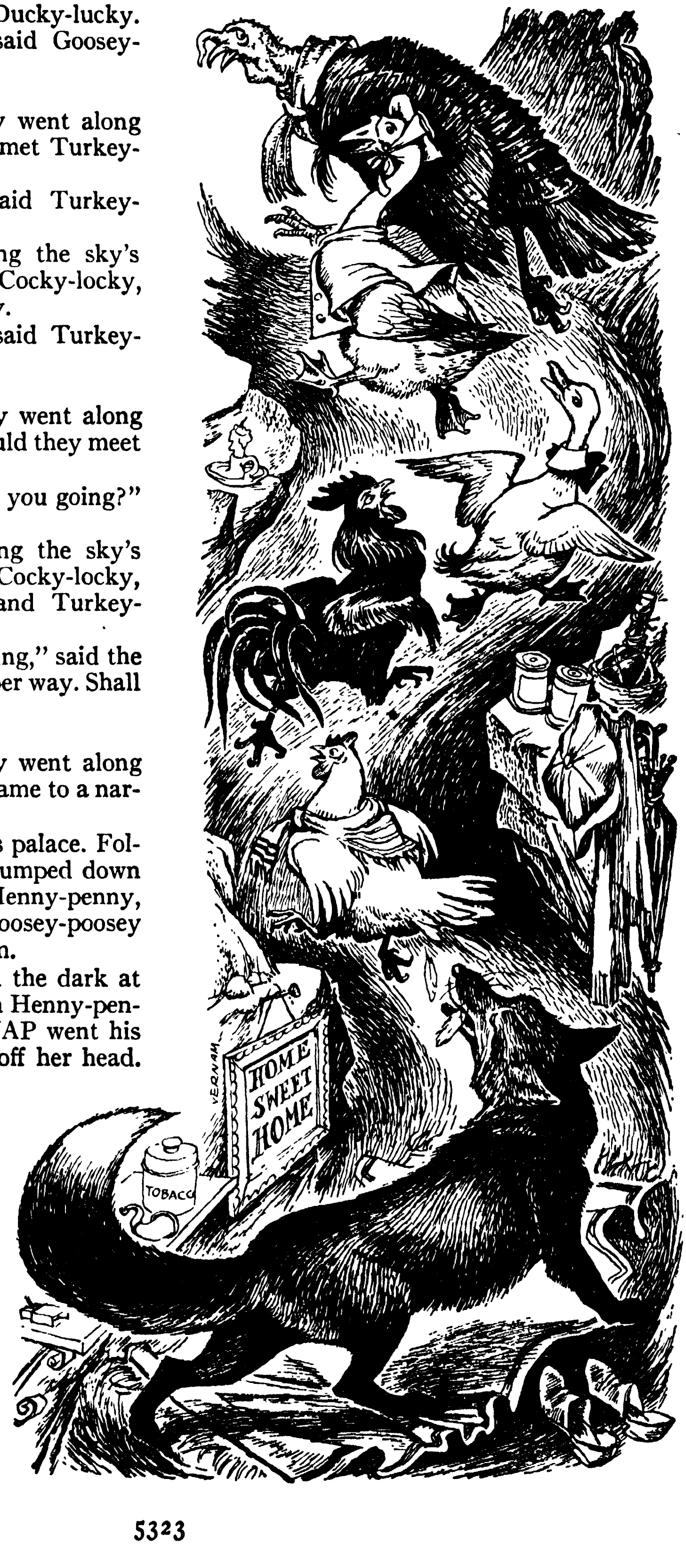
"Squawk, squawk!" cried Henny-penny,

"Cock - a - doodle - doo!" cried Cocky-locky.

"Quack, quack!" cried Ducky-lucky.

"Quonk, quonk!" cried Goosey-poosey.

"Gobble, gobble!" cried Turkey-lurkey. And they all ran out of the hole and they NEVER told the king the sky was a-falling.



THE WOLF AND THE SEVEN KIDS

There was once an old nanny-goat who had seven kids, and she was just as fond of them as a mother of her children. One day she was going into the woods to fetch some food for them, so she called them all up to her, and said:

"*My dear children, I am going out into the* woods. Beware of the wolf! If once he gets into the house, he will eat you up, skin, and hair, and all. The rascal often disguises himself, but you will know him by his rough voice and his black feet."

The kids said: "Oh, we will be very careful, dear mother. You may be quite happy about us."

Bleating tenderly, the old goat went off to her work. Before long, someone knocked at the door, and cried:

"Open the door, dear children! Your mother has come back and brought something for each of you."

But the kids knew quite well by the voice that it was the wolf.

"We won't open the door!" they cried. "You are not our mother. She has a soft, gentle voice, but yours is rough, and we are quite sure that you are the wolf."

So he went away to a shop and bought a lump of chalk which he ate and it made his voice quite soft. He went back, knocked at *the door again and cried:*

"Open the door, dear children. Your mother has come back and brought something for each of you."

But the wolf had put one of his paws on the window-sill where the kids saw it, and cried:

"We won't open the door. Our mother has not got a black foot as you have; you are the wolf."

Then the wolf ran to a baker and bought some flour to whiten his paws. Now he went for the third time to the door and knocked and said:

"Open the door, children. Your dear mother has come home, and has brought something for each of you out of the wood."

The kids cried: "Show us your feet first, that we may be sure you are our mother."

He put his paws on the window-sill, and

The wolf had put one of his paws on the window-sill, where the kids saw it and cried: "We won't open the door."

when the kids saw that these were white, they opened the door.

Alas! it was the wolf who walked in. They were terrified, and tried to hide themselves. One ran under the table, the second jumped into bed, the third into the oven, the fourth ran into the kitchen, the fifth got into the cupboard, the sixth into the washtub, and the seventh hid in the tall clock-case. But the wolf found them all but one, and made short work of them. He swallowed one after the other, except the youngest one in the clock-case whom he did not find. When he had satisfied his appetite, he took himself off, and lay down in a meadow outside, where he soon fell asleep. Not long after, the old nanny-goat came back from the woods. Oh, what a terrible sight met her eyes! The house door was wide open, table, chairs, and benches were overturned, the washing-bowl was smashed to atoms, the covers and pillows torn from the bed. She searched all over the house for her children, but nowhere were they to be found. She called them by name, one by one, but no one answered. At last, when she came to the youngest, a tiny voice cried:

"I am here, dear mother, hidden in the clock-case."

She brought him out, and he told her that the wolf had come and devoured all the others.

You may imagine how she wept over her children.

At last, in her grief, she went out, and the youngest kid ran by her side. When they went into the meadow, there lay the wolf under a tree, making the branches shake with his snores. They examined him from every side, and they could plainly see movements within his distended body.

"Ah, heavens!" thought the goat, "is it possible that my poor children, whom he ate for supper, should be still alive?"

She sent the kid running to the house to fetch scissors, needles, and thread. Then she cut a hole in the monster's side, and, hardly had she begun, when a kid popped out its head, and as soon as the hole was big enough, all six jumped out, one after the other, all alive, and without having suffered the least injury, for, in his greed, the monster had swallowed them whole. You may imagine the mother's joy. She hugged them, and skipped

There lay the wolf under a tree, making the branches shake with his snores. They examined him from every side.

about like a tailor on his wedding day. At last she said:

"Go and fetch some big stones, children, and we will fill up the greedy beast's body while he is asleep."

Then the seven kids brought a lot of stones, as fast as they could carry them, and stuffed the wolf with them till he could hold no more. The old mother quickly sewed him up, without his having noticed anything, or even moved.

At last, when the wolf had had his sleep out, and got upon his legs, he found he was very thirsty, and wished to go to the spring to drink. But as soon as he began to move, the stones began to tumble about in his body, and he cried out:

"What rattles, what rattles
Against my poor bones?
Surely not little goats,
But only big stones!"

And when he came to the brook he stooped down to drink, and the heavy stones made him lose his balance so that he fell, and sank beneath the water.

As soon as the seven little goats saw this, they came running up, singing aloud, "The wolf is dead! the wolf is dead!" and they danced for joy around their mother by the side of the brook.

THE STRAW OX

From BAIN'S COSSACK FAIRY TALES

THERE was once upon a time an old man and an old woman. The old man worked in the fields as a pitch-burner, while the old woman sat at home and spun flax. They were so poor that they could save nothing at all; all their earnings went in bare food, and when that was gone there was nothing left. At last the old woman had a good idea:

"Look now, husband," cried she, "make me a straw ox, and smear it with tar."

"Why, you foolish woman!" said he, "What's the good of an ox of that sort?"

"Never mind," said she, "you just make it. I know what I am about."

What was the poor man to do? He set to work and made the ox of straw, and smeared it all over with tar.

The night passed away, and at early dawn the old woman took her distaff, and drove the straw ox out into the steppe to graze, and she herself sat down behind a hillock, began spinning her flax, and cried:

"Graze away, little ox, while I spin my flax. Graze away, little ox, while I spin my flax!"

And while she spun, her head dropped down and she began to doze, and while she was dozing, from behind the dark wood and from the back of the huge pines a bear came rushing out upon the ox and said:

"Who are you? Speak and tell me!"

And the ox said: "A three-year-old heifer am I, made of straw and smeared with tar."

"Oh," said the bear, "stuffed with straw and trimmed with tar, are you? Then give me your straw and tar, that I may patch up my ragged fur again!"

"Take some," said the ox, and the bear fell upon him and began to tear the tar.

He tore and tore, and buried his teeth in it till he found he couldn't let go again. He

The old man set to work and made an ox of straw, and smeared it all over with tar.

tugged and he tugged but it was no good, and the ox dragged him gradually off, goodness knows where.

Then the old woman awoke, and there was no ox to be seen.

"Alas, old fool that I am!" cried she, "perchance it has gone home."

The old man tugged and tugged until he had pulled the wolf loose from the tarred ox.

She quickly caught up her distaff and spinning board, threw them over her shoulders, and hastened off home, and she saw that the ox had dragged the bear up to the fence, and in she went to her old man.

"Dad, dad," she cried, "look, look! The ox has brought us a bear. Come out and kill it!"

Then the old man jumped up, tore off the bear, tied him up, and threw him in the cellar.

Next morning, between dark and dawn, the old woman took her distaff and drove the ox into the steppe to graze. She herself sat down by a mound, began spinning, and said: "Graze, graze away, little ox, while I spin my flax! Graze, graze away, little ox, while I spin!"

And while she spun, her head dropped down and she dozed. And lo! from behind the dark wood, from the back of the huge pines, a gray wolf came rushing out upon the ox and said: "Who are you? Come, tell me!"

"I am a three-year-old heifer, stuffed with straw and trimmed with tar."

"Oh, trimmed with tar, are you? Then give me of your tar to tar my sides, that the dogs tear me not!"

"Take some," said the ox. And with that the wolf fell upon him and tried to tear the tar off. He tugged and tugged, and tore with his teeth, but could get none off. Then he tried to let go, and couldn't, tug and worry as he might.

When the old woman woke, there was no heifer in sight.

"Maybe my heifer has gone home!" she cried. "I'll go home and see."

When she got there she was astonished, for by the paling stood the ox with the wolf still tugging at it. She ran and told her old man, and he threw the wolf into the cellar also.

On the third day the old woman again drove her ox into the pastures to graze, and sat down by a mound and dozed off. Then a fox came running up. "Who are you?" it asked the ox.

"I'm a three-year-old heifer, stuffed with straw and daubed with tar."

"Then give me some of your tar to smear my sides with, when those dogs tear my hide!"

"Take some," said the ox.

Then the fox fastened her teeth in him and couldn't draw them out again. The old woman told her old man, and he took and cast the fox into the cellar in the same way. And after that they caught Pussy Swiftfoot, the hare, likewise.

So when he had got them all safely the old man sat down on a bench before the cellar and began sharpening a knife. And the bear said to him:

"Tell me, daddy, what are you sharpening your knife for?"

"To flay your skin off, that I may make a leather jacket for myself and a pelisse for my old woman."

"Oh, don't flay me, daddy dear! Rather let me go, and I'll bring you a lot of honey."

"Very well, see you do it," and he unbound and let the bear go.

Then he sat down on the bench and again began sharpening his knife, and the wolf asked him. "Daddy, why are you sharpening your knife?"

"To flay off your skin, that I may make me a warm cap against the winter."

"Oh, don't flay me, daddy dear, and I'll bring you a whole herd of sheep."

"Well, see that you do it," and he let the wolf go.

Then he sat down, and began sharpening his knife again. The fox put out her little snout, and asked him: "Be so kind, dear daddy, and tell me why you are sharpening your knife!"

"Little foxes," said the old man, "have nice skins that do capitally for collars and trimmings, and I want to skin you!"

"Oh! Don't skin me, daddy dear, and I will bring you hens and geese."

"Very well, see that you do it," and he let the fox go.

The hare now alone remained, and the old man began sharpening his knife on the hare's account.

"Why do you do that?" asked Puss.

He replied: "Little hares have nice soft, warm skins, which will make me nice gloves and mittens against the winter!"

"Oh, daddy dear! Don't flay me, and I'll bring you kale and good cauliflower, if only you let me go!"

Then he let the hare go also.

The old man and the old woman went to bed; but very early in the morning, when it was neither dusk nor dawn, there was a noise in the doorway like "Durrrrr!"

"Daddy!" cried the old woman, "there's someone scratching at the door; go and see who it is!"

The old man went out, and there was the bear carrying a whole hive full of honey. The old man took the honey from the bear; but no sooner did he lie down again than there was another "Durrrrr!" at the door.

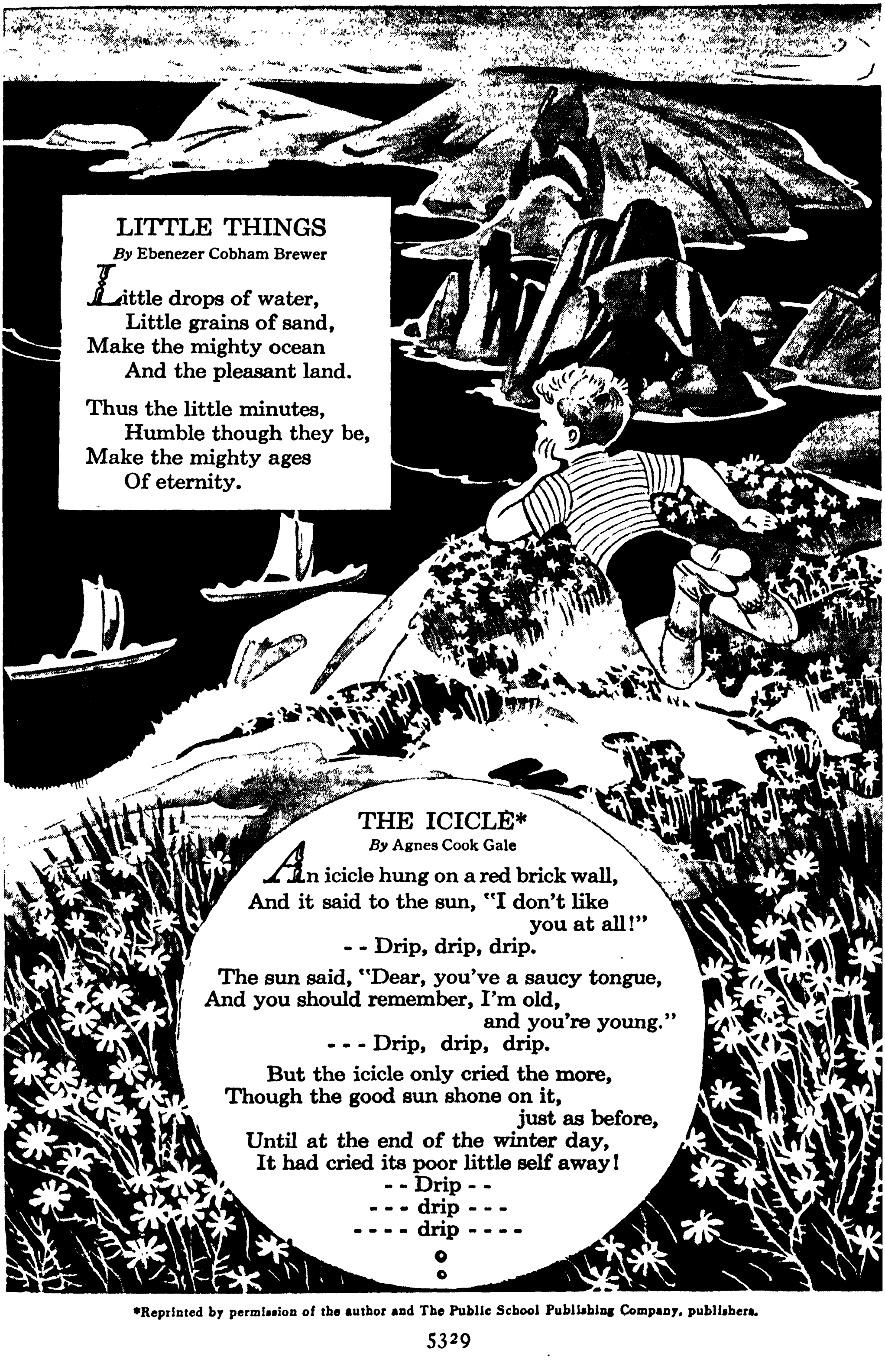
The old man looked out and saw the wolf driving a whole flock of sheep into the courtyard. Close on his heels came the fox, driving before him the geese and hens, and all manner of fowls; and last of all came the hare, bringing cabbage and kale, and all manner of good food.

And the old man was glad, and the old woman was glad. And the old man sold the sheep and oxen, and got so rich that he needed nothing more.

As for the straw ox, it stood in the sun till it fell to pieces.

THE NEXT READ ALOUD STORIES ARE ON PAGE 5921.

When he had got them all safe in the cellar, the old man sat down on a bench and began sharpening a knife.



LITTLE THINGS

By Ebenezer Cobham Brewer

Little drops of water,
Little grains of sand,
Make the mighty ocean
And the pleasant land.

Thus the little minutes,
Humble though they be,
Make the mighty ages
Of eternity.

THE ICICLE*

By Agnes Cook Gale

An icicle hung on a red brick wall,
And it said to the sun, "I don't like you at all!"
- - Drip, drip, drip.

The sun said, "Dear, you've a saucy tongue,
And you should remember, I'm old, and you're young."
- - - Drip, drip, drip.

But the icicle only cried the more,
Though the good sun shone on it, just as before,
Until at the end of the winter day,
It had cried its poor little self away!
- - Drip - -
- - - drip - - -
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THE SPONGES AS WE FIND THEM

Sponge photographs, courtesy Creswell Brothers, Limited

It is odd to think that the sponge we use was once alive, and is an animal product, not a vegetable growth, as it seems to the eye. The sponge lives in the sea, breathing oxygen like a fish. Water is drawn into it through little pores, and the food the water contains is devoured, the water passing out. As you can see from these pictures, sponges grow in many different and curious shapes.

THE SPONGE

A LOWLY ANIMAL THAT IS USEFUL TO MAN

THE common sponge is a familiar object, yet very few people know what a sponge really is. Most people wrongfully imagine that it is a sort of seaweed. Nor is it very strange, perhaps, that people should not know its true nature, for it was formerly one of the puzzles of science, and even yet it is in some ways rather a problem.

One old writer imagined that sponges were made out of the foam of the sea; another thought they were worm houses, built by worms much as bees build honeycombs, and wasps build nests; and another thought they were half bird, half animal. As a matter of fact, the sponges are really very lowly animals.

Animals may be considered in two great classes—those made of single cells and those made of more than one cell. Sponges are a simple form of the second class. They consist of many cells, and the dry material we use for various purposes is the horny skeleton which holds them together and gives them shape.

The fibrous skeleton has tiny cells plastered all over its surface in such a way that it forms a porous mass. The mouths and tiny pores on the outside lead into a network of tubes large and small. The cells set around the pores and mouths, and lining the passages, have little finger-like processes which all move together. A stream of water flows in at the pores and out again at the mouths. In this way food and the gases in the water are made to circulate to all the cells.

Some sponges reproduce their kind by growing buds on the parent animal. Among other species there are males and females, and the female sponges produce eggs that develop into single cells. At first they go swimming through the water, but afterward they take root and form such elaborate compound structures as we have attempted to describe.

Courtesy, American Sponge and Chamois Co.

The sponge-fisher looks through a glass-bottomed bucket, and gathers the crop with grappling irons. This method is used for sponges in shallow seas.

There are sponges of all shapes, sizes and colors. Some are the size of a pinhead, some as tall as a man; some are fan-like, some tree-like, some cup-like, and some basket-like; some are built on a horny framework; some are made of lime; some have a glassy frame. Some are snow-white, some grass-green, some sky-blue, some red, and some yellow. There are, in fact, many thousands of species of sponges. Most of them are not useful to us, but a number of different ones were used as long ago as the time of Homer. The husband of Venus, Hephæstus, or Vulcan, for instance, is described as bathing with a sponge.

The Greeks and the sponge are closely connected. Long, long ago in the clear rock-sown seas around Greece the young Greek diver toiled to bring up the curious sponge masses; the ancient warriors used sponges to pad their helmets; Greek merchants brought sponges into the London market early in the nineteenth century; and Greek divers, who learned their art in the Mediterranean, are the chief sponge-fishers in the waters of the

Sponge fishing has been carried on for more than two thousand years in the clear waters of the eastern Mediterranean; and this area is still profitably fished.

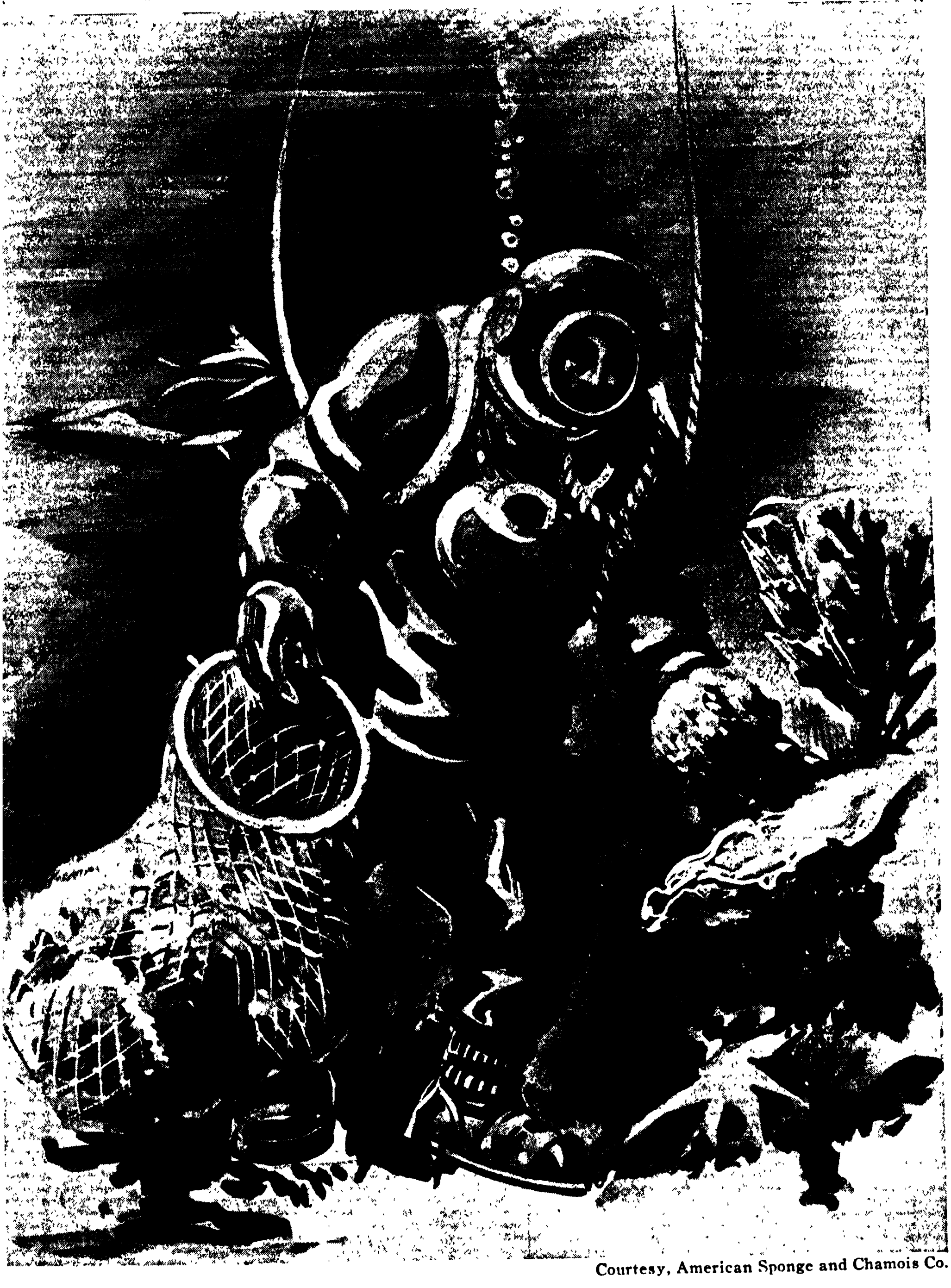
Gulf of Mexico to-day, using similar means.

Less than a century ago all the sponges used in this country were imported from the Mediterranean and Red Seas; to-day many of them come from the warm, clear waters off Florida, in the Gulf of Mexico and off the West Indies. When they were first found growing off the island of Key West the sponge-fishermen used to go out from their small ship, two by two in boats. The man in the stern sculled the boat, and the one amidship hooked the sponges. The hooker was armed with a long hook, 45 or 50 feet in length, and a water-glass—a bucket with a glass bottom—tied to the side of the dinghy. Pushing the water-glass beneath the ripples on the surface, the hooker rested on the thwarts facing toward the bow and pushed his head as far down into the bucket as possible. As soon as he sighted a sponge he dropped the water-glass and grasped his hook with both hands. A little hoist and he landed a fine sponge in the boat. His mate meanwhile was sculling very smoothly and gently along, so as not to cause the hooker to strain or to make him lose his balance.

To-day, however, most of the sponge-fishing is done by expert Greek divers clad in modern diving suits and carrying with them mesh bags in which to collect the gluey, strong-smelling masses. Since 1912 the Fernez apparatus has been much in use. In this case, the diver wears only a rubber mask with goggles, air valves and tubes; a small reservoir for air, belted to his back, is connected with a pump on the boat. The water in which the diver works is so clear that there is little danger except from sharks, which abound in some sponge-fishing areas.

Basketful after basketful is drawn up to the boat above, and then the sponges are carried to the big ship, where they are spread on deck and trodden under the bare feet of the crew until the slimy matter has drained out of them. While this process is going on, the mass gives off a very strong, disagreeable odor, which gradually lessens till it resembles that from seaweed. Next, the sponges are strung together and hung over the sides of the boat, where they are left awhile before being washed in tubs of sea water on deck. Or they may be taken to little water pens called kraals (corrals), where further soaking and cleansing is done. Then "bunches"

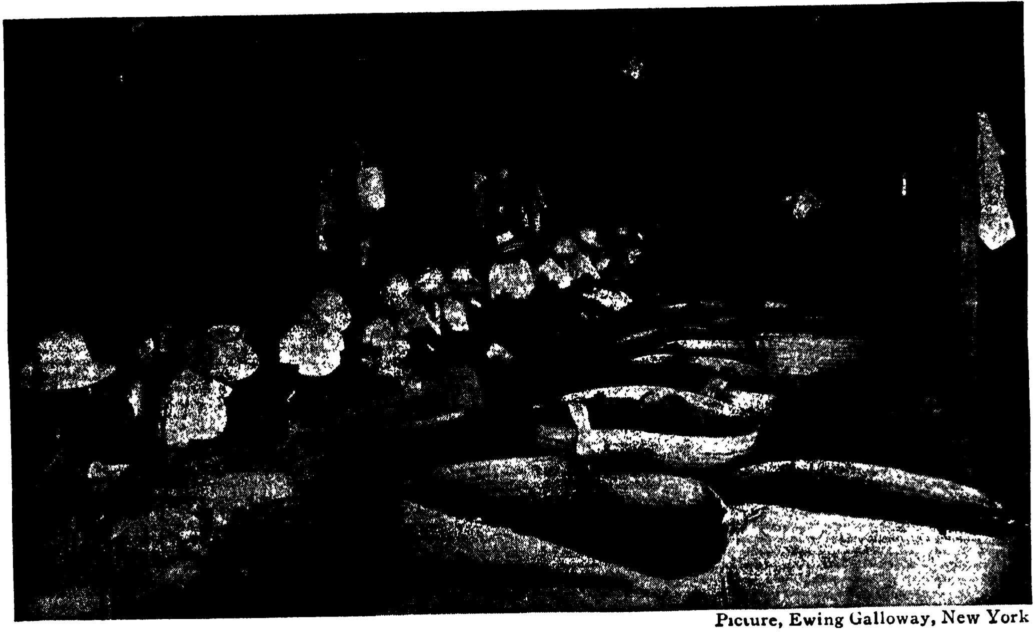
A DIVER COLLECTING SPONGES



Courtesy, American Sponge and Chamois Co.

Many sponges grow at depths too great to be reached by a pole and grappling hooks. These are secured by divers in modern apparatus that enables them to descend almost as far as 150 feet and to stay down there from half an hour to an hour and a half. The diver carries a net bag into which he packs his catch.

PREPARING AND SELLING SPONGES



Picture, Ewing Galloway, New York

Nassau, in the Bahamas, is one of the world's largest sponge fishing centres. Much of the work there is done by the Negroes, who, in the factory seen above, are trimming the sponges with scissors.

Courtesy, American Sponge and Chamois Co.

Sponges are sold mostly in the open market, by competitive bidding. The sponges are then graded and baled and shipped to all parts of the world. Here we see a market, the Tarpon Springs Exchange, in Florida.

r wreaths are made by stringing the pieces n cords six feet long and tying the ends ogether. After being partially dried, the ponges are taken to markets, where dealers uy them at auction in lots. Later, they re trimmed and sorted according to size, egulated by the number of pieces that it akes to make a pound. Some sponges are leached; but those that are naturally light n color are the most valuable. They are more durable than those treated with mineral acids, which sometimes weaken the fibre of the sponge.

Picture, Ewing Galloway, New York

When the sponges are brought to the surface, they are covered by a thin skin and in the pores is a slimy substance—the life-matter—that must be removed. Much of this cleaning is done on the fishing boats.

Though most of the sponges used in America come from the waters around Florida or the West Indies, the finest quality still comes from the Mediterranean and Red seas, where sponges have been gathered from the same waters for many centuries. The sponges of the Western World are generally coarser than those of the East. Though sponges are not used so much in surgery and in the bathtub as in former times, new uses have been discovered, and the demand continues heavy.

The beds of sponges are rapidly becoming depleted because they are constantly fished, without allowing time for the young sponges to mature. Because of this the United States Government has passed laws forbidding divers to take sponges between the first of May and the first of October. Revenue cutters have authority to seize boats engaged in fishing during the closed season. The law also forbids the gathering of sponges that are under five inches in diameter. This regulation does not harm the sponge-fishers, as a sponge of five inches is worth hardly a tenth of what it will bring after another year's growth. The best of the Florida sponges are the type called sheep's wool. These sell for \$2 to \$5 a pound. Other Florida varieties sell for 15 cents to 60 cents a pound.

Further measures are needed to provide for sufficient future supplies of sponge. With this in view, experiments in artificial cultivation have been made. Bits cut from a live sponge and fastened to a base, usually of cement, were sunk into shallow water. Sometimes the bits were strung on wires and hung under the surface of the water. They might grow fast enough to be ready for market in several years; but some were sure to die, and some bases were lost. The process proved expensive and unprofitable. A more successful method is to raise sponges from the egg, and it seems likely that sponge culture of this sort will soon be carried on widely enough to supply the market.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5401.

HOW TO IDENTIFY OAK WOODS

OVER fifty species of native oaks are large enough to be classed as trees; about twenty-five of these are used for lumber. After the oaks are cut into lumber it is practically impossible to identify the exact species of a given piece of oak. However, by examining the wood, we can separate the oaks into two general groups—the white oaks and the red oaks. For general construction purposes it is not necessary to classify the oaks any further. They all average about the same in strength, but those in the white-oak group are much more enduring than the red-oak group when they face conditions that tend to bring about decay.

The white-oak group includes the following: true white oak, swamp oak, burr oak, cow oak, post oak and chestnut oak. The red-oak group includes true red oak, yellow or black oak, scarlet oak, Spanish oak, Texan oak, water oak, willow oak and laurel oak.

A rough-and-ready method for distinguishing the white oaks from the red oaks is to examine the color of the wood. Red oaks usually have a distinctly reddish tinge, especially near the knots. The wood of the white oaks is generally a grayish brown. However, this test is not entirely reliable, since once in a while a reddish tinge is also found in white-oak lumber.

For more accurate identification it is necessary to examine the pores of the wood. These will appear as tiny holes on a smoothly cut end surface, the largest being visible to the naked eye. They are not of uniform size in each growth ring and they vary with the seasons. They are considerably larger in the wood formed in the spring, decreasing in size toward the summer wood. The large pores in the spring wood of the heartwood and inner sapwood of the white oaks are usually plugged up with a froth-like growth, called a *tylosis;* the pores in the spring wood of the red oaks are open.

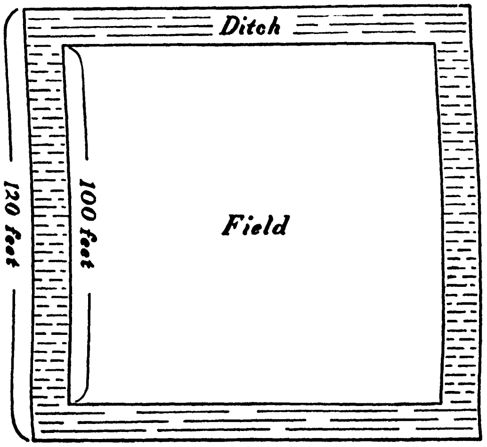
The following is the most reliable test of all. To identify a piece of oak wood, cut the end grain smoothly with a sharp knife across several growth rings of average width. With the aid of a magnifying glass examine the small pores in the dense summer wood. If the pores in this part of the growth ring are plainly visible as tiny rounded openings and are not so crowded but that they can readily be counted, the wood belongs to the red-oak group. If, on the other hand, the pores in the summer wood are very small and so numerous that it would be practically impossible to count them, the wood belongs to the white-oak group.

To be perfectly sure about the identity of a piece of oak lumber, it would be best to apply all three of the above tests.

HOW DID THE FARMER MAKE HIS BRIDGE?

A FARMER once had a field that was square in shape. It was surrounded by a ditch full of water; the outer edges of this ditch formed another square, having the same center as the square formed by the field. Each side of the field was 100 feet long; each outer edge of the ditch was 120 feet long.

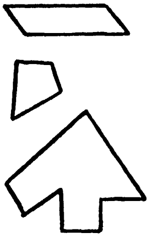
The farmer crossed over to this field from his farmhouse by means of an old wooden bridge. One morning he found that a heavy wind had demolished the bridge overnight. The farmer had to construct another bridge, of course, but the only lumber available for the purpose were two planks, each 10 feet long. Without cutting the planks, he so arranged them that he crossed over to the field. The solution is given on page 5600.



PUZZLES WITH PAPER AND SCISSORS

THERE are many different ways in which a given piece of paper or of cardboard may be cut up and then rearranged so as to form an entirely different figure. This rearranging process calls for much ingenuity and you will find it great fun.

A carpenter sometimes has to do something of the sort with the wood out of which he makes things. For instance, once a carpenter had to mend a hole in a door. The hole measured 6 feet by 1 foot, and all the wood that the carpenter had was a piece measuring 4 feet by 18 inches. The carpenter was greatly puzzled at first. Then, after thinking over the problem for a while, he got out his working tools and he sawed the piece of wood into two pieces. When these were put together, they fit the hole.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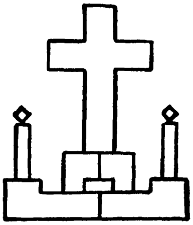
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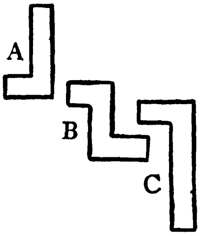

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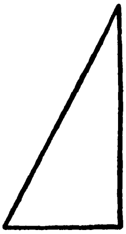

4.

Let us cut out of paper the shape of the piece of wood which the carpenter had. We should count inches for feet, so that our piece of paper will measure 4 inches by 1½ inches. Let us see if we can solve the problem that the carpenter had to face. In our case we must fit our paper into a shape that will be 6 inches by 1 inch.

Another carpenter was given a plank, measuring 15 feet long by 3 feet wide. With this he was told to lay down a floor that was to be exactly square. However, he was on no account to cut the plank into more than five pieces, and four of the five were to be equal in size. He thought for a few minutes and then he cut the plank as he had been told to. The five pieces of wood formed a perfect square. Let us cut out a piece of paper of the same shape as the plank, reckoning inches instead of feet, and let us see if we can cut it as the carpenter did, into five pieces that will form a perfect square.

There are many other puzzles of this kind that are very entertaining and that will give you a fine chance to exercise your wits. Here is another puzzle. If we take a sheet of paper and cut out from it four of each of the three shapes shown in figure 1, we can fit these twelve pieces together so as to form an octagon, or eight-sided figure. We can easily trace the shapes from this page, on a piece of thin tracing paper, transfer them by means of carbon paper to cardboard and then cut out the various pieces.

Here is still another puzzle. Cut out eight equal squares. Take four of these and divide each into two equal triangles by cutting across one corner to an opposite corner. We now have four squares and eight triangles —that is to say twelve pieces in all. Now let us fit all these pieces together so as to form a perfect square. This problem requires considerable thought, but it is not as difficult as it seems.

Still more ingenious is the following puzzle. The cross with candles shown in figure 2 is made up of nine pieces, as you can see. First take a piece of paper, oblong in shape and 4 inches by 2½ inches in size. Fold this paper in such a way that with one cut of a pair of scissors you will divide the paper into the nine pieces which you must have to form the cross and candles shown in the illustration.

Here is a somewhat simpler puzzle. Cut out three pieces of paper of the shape of A in figure 3, and one piece each of the shape of B and C. Now put these five pieces of paper together to form a cross.

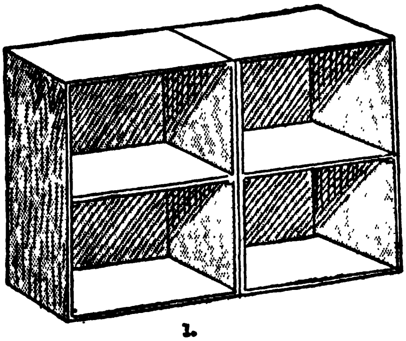
Another interesting puzzle is to cut out twenty triangles, the shape of the one in figure 4 and to arrange the twenty triangles so that they will form a square.

Some curious results may be obtained by drawing triangles. Here is an example. Cut out of a piece of paper an equilateral triangle, that is, a triangle that has all its sides equal. Now let us draw upon the triangle thirty straight lines in such a way that we make the greatest possible number of triangles. What is the largest possible number of triangles that we can make thus?

The solutions to all these interesting puzzles will be found on page 5339.

A CABINET MADE FROM CIGAR BOXES

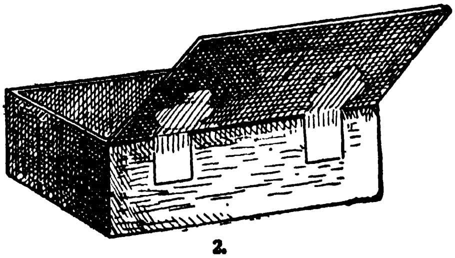
WITH three cigar boxes we can make a little wall cabinet that will serve many useful purposes and that will be ornamental as well. Two of the cigar boxes should be of exactly the same size. The third box is to be larger than the others. This box is to be taken to pieces so that we may use its wood in constructing the cabinet.



1.

First we must take off all the paper on the boxes. This can be done very easily by using a wet sponge and letting the boxes stand for several minutes before starting to remove the paper. When we have removed all the paper we must be sure to allow the boxes to dry gradually. We should not try to hasten the drying process by putting the boxes upon a radiator or some similar hot surface; this would probably crack the wood.

We take the third box apart. In doing so we try to be as careful as possible not to split the pieces, which we shall soon use. If the nails are in good condition when they are removed they may be used again to nail the various parts of our cabinet in position. If the nails have been bent, however, do not bother to straighten them but use new nails for your task.

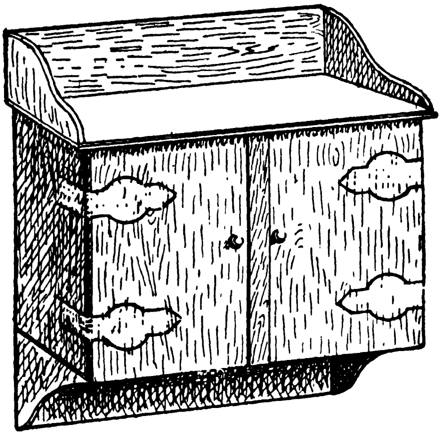


2.

We now cut strips of wood from the cigar box that we have taken to pieces, and we fit them into the cigar boxes, as shown in figure 1, to do duty as shelves. Two nails through each of the two sides of each box will keep the shelves in position.

Now we take two pieces of linen, cut them to some ornamental shape and glue them to the back and lid of each box, so as to make hinges, as shown in figure 2. If the cigar box has a brand mark burned in on the outside of the lid, we turn the lid over so that the inside part now becomes the outside part. Next we glue the front sides of the two boxes face to face and this will give us a two-compartment cabinet, with a shelf in the middle of each compartment as in figure 1.

A piece of wood slightly longer and wider than the top dimensions of the cabinet is now to be glued upon the top of it (see figure 3). You will note that at the top and bottom of our cabinet there are ornamental pieces, consisting of sides and back. These are to be cut out of the broken box and adjusted into position as shown. They are to be glued in place. A few nails will help; we must be careful, however, not to split the wood, if we use the nails.



3.

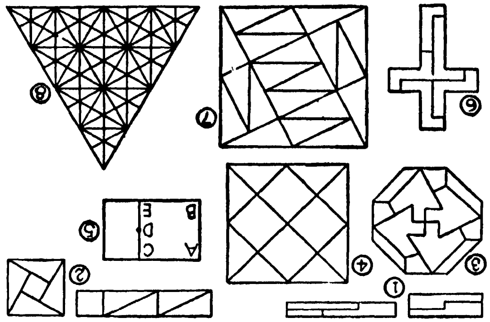
We make the ornamental backs at the top and bottom of our cabinet secure by using cleats. These are made from pieces of the broken box. They are placed in such a way that half of each cleat will be set upon the back of the cabinet and the other half upon the ornamental back. The cleats may be fastened by means of tiny nails, or else they may be glued into position.

Next we are to cut a narrow strip of wood the length of the doors and about an inch wide. We glue this strip to the edge of one of the doors so that it will come over the edge of the other door, as seen in figure 3. Finally we add two knobs, one for each door as shown in figure 3. Tiny brass screws will serve your purpose. If you wish, you may decorate the cabinet with stenciling. Our cabinet is now finished and ready to be hung upon the wall of your room. It may be hung by means of picture wire, attached to small nails or screws set in position on the back of the cabinet.

You will find that the cabinet has many uses. It will be very convenient for museum specimens, for tiny bottles, for seeds and for many other things.

SOLUTIONS TO THE PUZZLES WITH PAPER

HERE are the solutions to the puzzles given on page 5337. This is the way in which the cross, stand and candles are made, in the sixth puzzle. Four folds have to be made before the cutting is done. Suppose that figure 5 represents the piece of paper. First mark off the square ABEC. Now fold corner A over to E; fold B over to C; fold C to E; fold D to E. Then cut the paper lengthwise along the center. You will then have nine pieces of paper, which will form the cross, stand and candles. There are at least 96 triangles in figure 8.



HOW TO FIT WINDOW SHADES

IN attaching, hanging and adjusting window shades, we should bear in mind that the shade should always roll smoothly and should stop at the desired place.

The first step in fitting window shades is to attach the shade to the roller. Fold over ½ inch of the roller end of the shade (this is to serve as reinforcement) and then tack the shade to the roller.

Next, the hangers upon which the roller is to rest are to be attached to the window-frame. Roll the shade up all the way on the roller. Then adjust the roller in the position that it will occupy when resting upon the hangers. Put one of the hangers in the proper position; then make a pencil mark for the hanger at the desired point. Attach the hanger with nails or screws. Screws are more satisfactory as they will hold the hanger more firmly in place.

Now place one end of the roller in the hanger that you have just set up. Place the other hanger in the position that it will occupy and make a mark as before to indicate that position. Remember that the hangers should be close enough together or else the shade will fall out. Attach the second hanger just as you did the first.

Your hangers are now in position. Now put your shade in place between the hangers. If you find that these are too close together and that your roller does not fit between them, just bend them out slightly and the shade will drop into place.

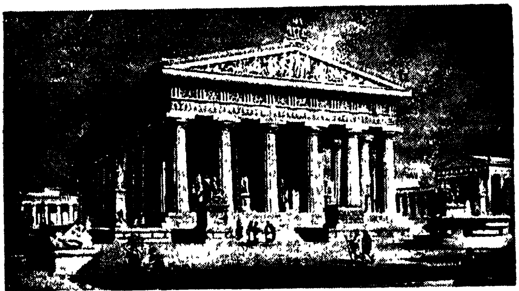
The next thing to do is to adjust the tension of the roller spring. First the spring is to be released by releasing the trigger at the side of the roller. If this is done too abruptly the spring may be broken. The best way is to hold the trigger firmly in your left hand and to hold the right hand around the shade. Let the shade revolve for several turns; then grasp it firmly in the right hand. Release the shade again for several turns and repeat the process until the spring has been fully released.

Now roll up the shade in your hands all the way; replace it in the hangers. If the shade does not work freely, pull it down about two-thirds of the window-length. Then remove the shade from the hangers and roll it up all the way. If it still does not have the right tension, pull it down a little less or a little more before removing it from the hanger and rolling it up in your hands.

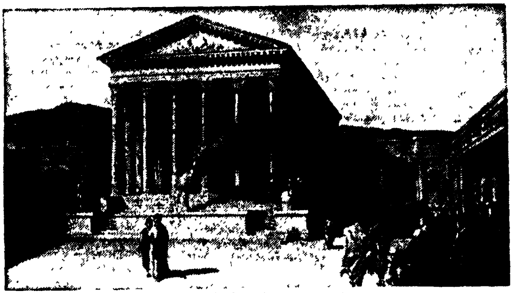
THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 5507.

BUILDINGS OF OLD GREECE AND ROME

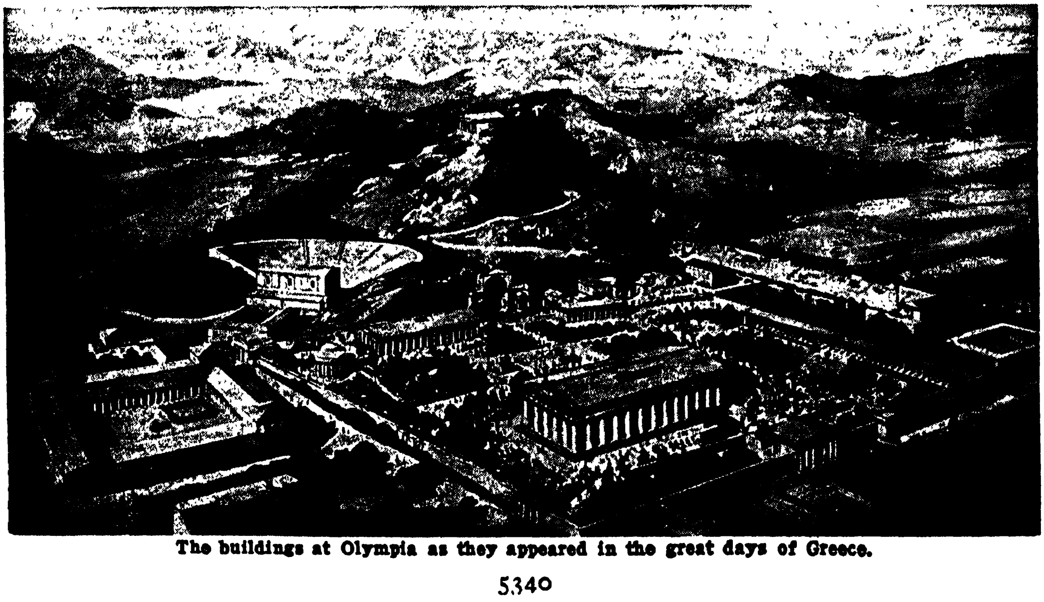
A reconstruction of the Appian Way, by which Paul walked to Rome.



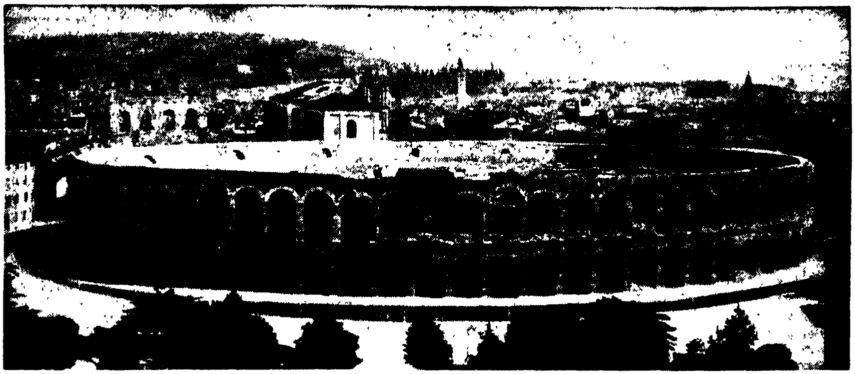
Poseidon's Temple at Pæstum as it was.



The Temple of Jupiter at Pompeii.



The buildings at Olympia as they appeared in the great days of Greece.



The old Roman amphitheatre at Verona.

THE GREEK AND ROMAN BUILDERS

WE know from our chapters on sculpture how this small people, the Greeks, in an insignificant country, and within the short span of a few hundred years, stamped the world unalterably with their forms of beauty. And in architecture, as in sculpture and letters, they were destined to a unique place. It would seem as if some god had shaped them, as King Arthur modeled his order of the Round Table:

> A glorious company, the flower of men,
> To serve as model for the mighty world
> And be the fair beginning of a time.

It is over two thousand years since these masters of art set up their buildings, and they are still the model for a world which has passed through changes and developments inconceivable to them.

Now, we can all judge paintings and we can all judge statuary. Judgment of architecture is not so easy, because, to use a homely saying, there is more in it than meets the eye. And a great many people are uncertain about Greek architecture. They want to know why it is so wonderful. It is wonderful because it is not only inspired by a sense of beauty, but it is reasonable, logical and sane.

A building, large or small, is put up in order to roof in a certain space. If it is a good building it must give the impression of having been thought out as a whole, and not just put together, hall on hall, chamber on chamber, and a back entrance and front entrance added. In reviewing the architecture of the Greeks we are bound to speak of their temples and occasional monuments only; their private dwellings and such palaces as they had have not survived the tragedies of their later history. We can only surmise what they were like from the houses of Pompeii and Herculaneum, which were built under Greek influence.

The keynote of their temple architecture is its simplicity. The building was a rectangle, plain and severe, with a gable at each end. Except for sculptural decorations—which were kept within the inclosing rectangular shape—the only "trimmings" were rows of columns. And the genius of this restrained classic architecture lies in its perfection of proportion. Its proportion is so perfect to the smallest detail that if a man studies and memorizes the construction of a temple front, it is as if he had learned the grammar of a language.

Proportion in architecture is a technical and very wide subject. It means, among a great many other things, that the mass of a building must not be too long for its width, or too tall for its breadth. It means that vertical and horizontal lines must not make too broad a shape or too narrow; that a line must be stopped properly and not just end; that a column must not look too thin to carry the weight on it, or so thick that it appears clumsy and out of place: "a column with a building added."

THE BEAUTY OF A BUILDING WITH ITS PERFECT PROPORTIONS

We may never have time to study properly the laws of proportion, but we can remember this: perfect proportion reaches out to where calculated skill ends and beauty begins. Or, to put it another way, a building perfectly proportioned is in itself beautiful, no matter of what material or color, or how plain it is—it delights the eye.

Greek architecture was characterized from the first by the use of columns and by its square, not arched, openings. The genius of its builders was spent in carrying this style to its utmost finish. In so doing they took what seemed to them good of other countries' work and refined it to their own use. They left behind the gorgeous splendor of the Assyrians and the secretiveness of the Egyptians. Their ideas of suitability were reasonable and sane. They did not want to build temples like those on the banks of the Nile, inclosed in a mighty blank wall, with all their beauty concentrated in the dim, mysterious pillared hall where only the privileged might enter. The Greek temples were for the Greek people: they were open to the sun and air, and looked happiest when men and women were passing to and fro.

THE FINE MARBLE THE GREEKS USED FOR THEIR BUILDINGS

The Greeks were fortunate in possessing an unlimited supply of the finest marble. Nearly all their buildings, and all their most important buildings, were constructed of this very delicate and exacting material. It was partly because they worked in marble that their construction was so perfect in detail and had such a smooth and fine effect. There is a natural clumsiness in stone that hides small defects in treatment, but marble hides nothing. So that the beauty of the Greek work was the beauty of accuracy, the beauty of a musical note struck exactly in the middle.

These people lived in a land of clear air, brilliant suns and sudden, short rains. It was essentially an out-of-door life, and it is probably because of this that no great municipal buildings were erected. Politics and philosophy were discussed out in the town, dramas played, poetry recited, tales told, in the open air. It has been suggested that this is one of the reasons why all the temples have open, pillared porticoes where people could take refuge from the shower. In any case, the Greeks loved the effect of drifting sun and shadow falling rhythmically across the columns of their temples. The greater buildings had columns all around; all of them had columns front and rear. Inside the ranks of this beautiful guard was the sacred building, enshrining the chamber where stood the statue of the god or goddess.

The temples were set in a kind of sacred inclosure, in the most effective place, generally the acropolis—the hill of the town or upper city. Sometimes when we see a drawing showing a reconstruction of the Parthenon as it was in Pericles' time, it seems to us rather a severe building, standing alone on its three-stepped platform, or *stylobate.* We should try to see it in the mind's eye—a dazzling mass of marble, crowning a hill above a sapphire sea, with flying clouds, and movement, and life about it.

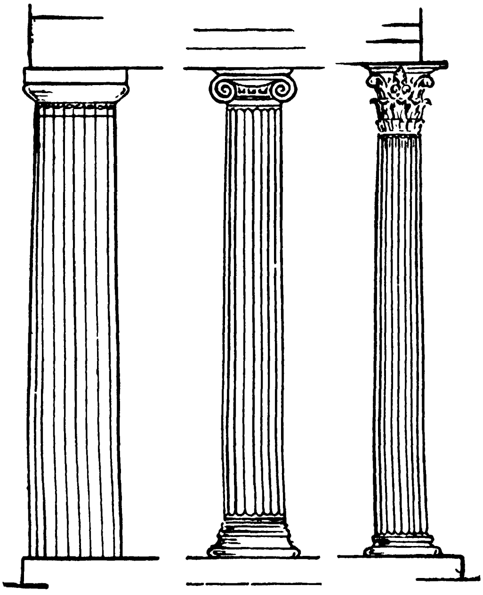
THE THREE KINDS OF COLUMNS ON WHICH GREEK TEMPLES WERE BASED

Just before the time of Jesus Christ a learned Roman architect named Vitruvius wrote a book on Greek architecture, and he classified it according to the different kinds of columns and the *entablature,* or the horizontal portion supported by the columns. This fragment of architectural design he called an Order, because its parts were framed according to a strict rule and order, and not put together by chance.

The "label" has been used ever since, and so we have the Doric Order, the Ionic Order, the Corinthian Order, so named from the three columnar designs on one of which all Greek temples were based. The Romans added two more, the Tuscan and the Composite.

These five Orders have been for almost two thousand years a kind of Bible to students of architecture. By far the most important is the Doric; then comes the Ionic; the Corinthian was evolved when Greece was under Roman rule, and can therefore scarcely be classed with the other two, which are pure Greek.

The Doric column is said to be the most perfect detail of architecture ever evolved, and depends for its beauty on its extreme simplicity and the genius of its proportions. It might sound rather childish to say that the chief thing about a column is that it must stop somewhere and somehow; but it is nevertheless true. There are millions of columns in the world, and we can scarcely pass through a city without seeing many kinds. And as we are busy with our own work, it has probably never occurred to us that a column is ugly or beautiful according to the proportion of thickness to length, to its base, and the manner in which it is connected with the part of the building resting on it.



THE COLUMNS IN GREEK ARCHITECTURE

The Doric column has no base; it stands directly on the steps of the temple, as we can see in the photographs of the Parthenon and the Theseum, at Athens. As it has no base, it cannot have too elaborate a capital. The shaft of the column is in a definite proportion to its height, and it tapers as it rises. We can easily see it grow in imagination, or for that matter we can carve one for ourselves. A square column has its corners shaved off; it is now eight-sided; again its corners are shaved off; it is now sixteen-sided. These sixteen planes are hollowed out—"fluted"—and there is the Doric shaft. Sometimes it had sixteen, but the general number of flutes was twenty.

Although the base of the column stands directly on the ground, the top cannot rest directly under the *architrave*—the plain, horizontal block of marble that comes next to the column—because it looks ugly. And anything that looks ugly is wrong. The fluted shaft needs to be connected in some way with the architrave.

First, near the neck of the shaft comes a single horizontal line, a warning that the long vertical lines of the flutes are about to end. Then the neck itself is grooved by a number of horizontal lines. Over it the *echidnus* broadens out as a support for the *abacus,* which in turn supports the architrave. One of the chief beauties of this famous Order lies in the skillful way in which the horizontal and vertical lines play against each other.

When we look at a photograph of the Parthenon we notice that the architrave is a long line of plain marble, but we do not always see that this undecorated, ungrooved stretch is one of the beauties of the Parthenon. It has a double value. It is a horizontal mass occurring immediately above the vertical mass of the columns and immediately below the vertical lines of the *triglyphs* that form part of the frieze. Also, as we have said, it is a plain mass set between two decorated masses—the grooved columns and triglyphs, and the sculpture of the *metopes*. Triglyphs and metopes alternating make the frieze—an endless repeat of three vertical bands and a square relief. On these triglyphs rests the weight of the roof.

There are no traces of windows in the Greek temples with which we are familiar. It is supposed that enough light came in through the open doorway. And this we can understand, as the light in that sunny land has such a brilliant quality.

The Doric Order was the earliest evolved in Greece, and most of the temples of her great years are built in this style. The Theseum, the temple of Theseus, is in the best state of preservation, but its columns are not so beautiful as those of the Parthenon. At Olympia there was the temple of Zeus, and at Ægina the temple of Aphaia. All these were built in the fifth century. The Parthenon is the greatest, as we have said on page 4221.

The Ionic Order was built up on the same principle as the Doric, but its proportions were different; it was less massive, less severe, more ornamental. The length of the Doric shaft was about five times the diameter of its base. That of the Ionic was about nine times the diameter of its base. The Ionic shaft was fluted, like the Doric, but the sharp edges between the flutings were planed down. The Doric shaft rested on the stylobate, or uppermost step; the Ionic had a molded base, generally of three layers. Instead of the plain, massive capital of the Doric, the Ionic had a scroll-shaped capital, its lines not unlike the spiral curls of the nautilus shell. It is this capital which is the chief distinguishing mark of the Ionic Order.

In all their work the Greeks were careful to leave the architrave plain; or, if a line were inserted, it was a horizontal line, thus strengthening the unbroken horizontal effect. In the Ionic Order the frieze ran continuously above the architrave, and was not broken up into triglyphs and metopes like the Doric frieze.

THE LITTLE IONIC TEMPLE NO BIGGER THAN A HOUSE

One of the most exquisite little temples in the world—that of the Wingless Victory on the Acropolis at Athens—was built in the Ionic style. It very well represents almost every feature of Ionic architecture. For some reason it pleased the architect Callicrates to make this temple just about as big as a house. The lovely little frieze which ran round it, above the Ionic columns, is in the British Museum, in London. The temple, as it stands, was reconstructed from the ruins left by the Turks about the middle of last century.

A much larger Ionic temple was the Erechtheum, also on the Acropolis, and it shares with the Temple of Diana at Ephesus the honor of being the greatest Ionic buildings set up by Greek architects. In planning the Erechtheum the architect Mnesicles departed from the usual Greek idea of a severe rectangular edifice, and threw the shrines of three different temples together, each abutting on the other, with no symmetry in the whole. At the south side is the famous Caryatid portico. The Caryatids are statues of women in flowing robes. At the north is another portico of very elaborate Ionic columns. A great deal of extra carving was done on them. Among other things on the abacus was the "egg-and-tongue" ornament so familiar to students in art schools.

In a great many of their temples the Greeks applied color to their pillars and gold and color to throw up the figures on the friezes. This effect was gained in the Erechtheum by the use of black marble as the groundwork of the frieze. The sculptured figures in white marble were attached to the black background by metal clamps. We can imagine how gorgeously beautiful and effective the finished building was.

HOW THE TURKS SPOILED THE BEAUTIFUL TEMPLES OF ATHENS

It is one of the world's tragedies that most of this Greek architecture should be in partial ruin, or in a state of reconstruction. Lovers of art find it difficult to forgive the Turks their barbaric treatment of Athenian temples during the time of their occupation. They turned the Erechtheum into the women's quarters of a great household. Other troubles came on the temple, and at last Nature herself brought ruin through a great storm, in 1852, which threw down a good part of the re-erected building.

A similar tale attends that marvelous pile so rightly called by the ancients one of the wonders of the world—the Temple of Diana at Ephesus, in Asia Minor. You may find a picture of this on page 2608. It stood on the site of an archaic building—fragments of whose columns are in the British Museum—which was burned down the night Alexander the Great was born, in 356 B.C. The "new" temple was built during Alexander's reign by Democrates, the architect, with Scopas, as master sculptor, supervising the work of a large number of artists.

This Temple of Diana was the centre of a great part of the national life of that province of Asia. It was more than a building: it was a living institution. Like the medieval monasteries of England, it owned land and had a large income. All the festivals of the district were held there, and a great army of priests and what the Bible calls soothsayers were attached to the temple. Public funds were housed in the precincts. In fact, to have uprooted the Temple of Diana during the first three hundred years after its erection, would have been to tear out the heart of Ephesus.

DEMETRIUS, THE SILVERSMITH, CRIES OUT AGAINST PAUL

A very rich trade of making silver images and shrines of Diana—much like that of the Christian craftsmen of early Europe—was carried on, as we know from the Acts of the Apostles. These images, together with the temple itself, were denounced by Paul and his followers, and this was the occasion of a great outcry.

> "Sirs," cried out Demetrius, the silversmith, "ye know that by this craft we have our wealth. . . . Not alone at Ephesus, but almost throughout all Asia this Paul hath persuaded and turned away much people, saying that they be no gods which are made with hands . . . so that the temple of the great goddess Diana should be despised, and her magnificence should be destroyed, whom all Asia and the world worshipeth." And when they heard these sayings they were full of wrath and cried out, "Great is Diana of the Ephesians!" And the whole city was filled with confusion. . . . All with one voice for about the space of two hours cried out "Great is Diana of the Ephesians!"

Pliny, the Roman historian, wrote a description of the temple, and from that information architects have been able to reconstruct it. There is no doubt that on the temple a great wealth of art was spent. The ranked Ionic columns had wonderful sculpture running round their bases and the lower parts of the shafts. The *pediment*—the triangular piece of wall between the cornice and the roof of the temple front—was a mass of magnificent carving, showing Diana on her throne, with princes and horses, lions and rams, on either hand, in a procession of honor.

THE BREAKING-UP OF THE GREAT TEMPLE OF DIANA

Toward the middle of the third century after Christ the temple was mutilated by the Goths, and about a hundred years later it was denounced and closed altogether at the order of the Christian Church. It then became a kind of quarry whence the best marbles were hewed out to help to build the churches of the "new" religion. A great deal of it went into the Cathedral of St. John at Ephesus; eight of its dark green marble columns are in the Church of St. Sophia, Constantinople. The rest of the temple ruins became slowly buried under the dust and débris of succeeding centuries, and lay at peace there, forgotten by spoilers. In 1869 an English architect, Wood, began a course of excavations, and took fragments back to England. These are now with the fragments of the earlier archaic temple in the British Museum.

There is a pretty story told by Vitruvius about a Corinthian bronze-worker called Callimachus. One day this man saw on a girl's grave a basket with acanthus leaves curling up around it. A square, flat stone, or tile, lay on the basket. The general shape took his fancy, and from the idea he fashioned in bronze the capital of a small column, in shape like an inverted bell, sheathed with acanthus leaves.

This is said to be the origin of the Corinthian Order, with which we are probably more familiar than with either the Ionic or the Doric, because it has so often been used, and is used to-day, in design and in ornaments, like candlesticks, and in monumental stones for graves, and in woodwork, and in so-called classical architecture.

THE TOWER BUILT FOR WATCHING THE PASSAGE OF THE SUN

The Corinthian Order, as we have said, was used by the Greeks less than were the other two Orders. The shafts have a molded base, much like the Ionic, and the Corinthian also largely resembles the Ionic Order in the way the columns support the roof.

Not many large buildings were planned in this Order, but there are several smaller temples, buildings and monuments, like the Temple of Apollo at Miletus, the famous Choragic Monument of Lysicrates, at Athens, and the Tower of the Winds, built for observing the passage of the sun and for recording time, also at Athens.

The Choragic Monument, which was typical of a great many in the Street of the Tripods, was a circular structure built on a deep square base, and measuring, in all, a height of some thirty-four feet. Six Corinthian columns, eleven feet high, stood round the body of the monument. Above them was a marble dome crowned by an ornament framed to hold the tripod. This was a prize given to the winner in certain games, and was fashioned on the original Tripod, a peculiar seat where the Delphic priestesses sat when they pronounced their oracles and "inspired" sayings.

THE OLD GREEK TOMB WHICH IS NOW IN THE BRITISH MUSEUM

The Greeks, no less than the Egyptians, honored their dead and made tombs for them, though not by any means on a stupendous scale. One of the earliest, built at Xanthos about 550 B.C., the Harpy Tomb, is now in the British Museum; and there also is a model of the Nereid Monument. This was a little building, also from Xanthos, surrounded by Ionic columns, built about two hundred years later than the Harpy Tomb.

We read of the Mausoleum on page 4332. On page 4466 are pictures of the lovely tomb of The Weepers and the Alexander Sarcophagus, both in the Constantinople Museum. These are the most important, and are monuments of beauty. But on all their tombs, whereof numerous fragments remain, the Greek architects and sculptors expended a very fine and finished art.

THE OPEN-AIR THEATRE WHICH HELD THIRTY THOUSAND PEOPLE

Their most important erections, next to the temples, were the huge open-air theatres, many of which still exist, though in a ruined state. They were built outside the town in a hollowed space or in a natural rocky basin. The germ, or kernel, of the theatre was the circular orchestra; two-thirds of the way round it rose tier upon tier of seats, invariably cut out of the solid rock in blocks. Behind the orchestra, on a kind of platform, stood the stage, built of stone, forming a permanent background to the play.

The principal theatre of Greece, the theatre of Dionysus at Athens, was an enormous place, capable of holding thirty thousand people. That at Epidaurus, not so big, was more beautifully planned. It was built by Polyclitus about 350 B.C., and is in a wonderful state of preservation.

The Greeks had buildings for athletic contests, stadia and hippodromes for races, and gymnasia for exercise, bathing and amusement.

Greek architecture was a one-storied architecture, had no towers, no arches, no upward fling from the body of the building. It had no mystery, no thrill of the half-lights of Egyptian temples. It was not a stupendous, awe-inspiring architecture. There are many ordinary churches in North America bigger than the Parthenon. Its beauty was the beauty of logical thought, which showed in its simplicity and proportion, and the beauty of an exquisite finish and perfection of detail.

ROMAN ARCHITECTURE BORROWED FROM BOTH GREEK AND ETRUSCAN

The Romans were the inheritors of Greek civilization abroad and Etruscan at home, and they took what seemed to them best from both styles of architecture. From the Etruscans they took the art of massive wall building, the construction of the arch and the dome—which the Etruscans in turn had inherited from the East—and developed them in their characteristically powerful fashion. From the Greeks they took their columns and square openings.

The Greek style suffered at the hands of the Romans. It would seem that the barbaric strength of the Etruscan work secretly pleased them, but they had a great admiration for Greek art, and in many cases when they had planned a building on the Etruscan style, they proceeded to decorate it in the Greek style.

They made strong arches, and then on the piers of the arches put a surface column which supported the entablature—the horizontal portion—above the rounded shape of the arch. So that inside was the arch of the Etruscans, the real strength of the structure, and outside, adorning it, lay the vertical and horizontal decoration of the Greek columnar openings.

We can see this at a glance if we look at the picture of the Colosseum at Rome. As the Greek columns had been designed for strength to support the roof, and always ran the height of the building, it was perhaps bad art and quite unnecessary to use them as facings for one story only. But the idea grew and became a distinct style, reappearing in European architecture centuries later.

THE ENDURING STRENGTH OF THE AQUEDUCTS THE ROMANS BUILT

When the Romans were simply building for strength and enduring qualities, and not trying to be artistic, as in their famous aqueducts, they did not trouble to add the Greek columns and architraves, and they built something extremely beautiful and dignified, and never to be forgotten. The aqueduct known as the Pont du Gard at Nîmes, in France, is one of the finest things in the world, infinitely more beautiful than the Colosseum. We cannot understand how they could look at it, or the Aqua Claudia, at Rome, and not see that they had achieved a singular greatness. Whereas it would seem that they said to themselves: "We must have aqueducts, because a town without a good water supply is no town. We must have bridges, because an empire without unbroken highroads is no empire. Let these be made plain and unadorned; we merely ask that they shall last forever. And *then* we will have some really beautiful buildings."

But not all their buildings were planned in a combination of arch and square, columnar openings. Some of their temples and basilicas, or public halls, had many columns supporting the roof or portico openings, and might be described as Roman-Greek, a style wherein the Greek was curiously spoiled and vulgarized by a people who lacked the exquisite Grecian taste. Generally speaking, the Romans were more showy, more ornate. Only one thing did they simplify, and that was the Doric column. To their variation of this Order has been given the name of Tuscan. The other of the two Orders evolved by them was the Composite, whose capital was a mixture of the Corinthian and the Ionic without the pure grace of either.

WHY THE ROMAN ARCHITECTURE DIFFERED FROM THE GREEK

There were two chief reasons for the distinctive style which Roman architecture developed as the empire grew. One was the material to hand, and the other the fullness and complexity of their life. Because of this it was inevitable that their work should fall away in an ever diverging line from the Greek style they admired. Greek architecture, produced by a company of artists, was an architecture of religion; that of the Romans, produced by a race of builders, was the architecture of a great and ever widening empire. The one was centred on the Acropolis, the other in the Forum, or market place, where men gathered to buy and sell, to discuss politics, to learn news. Round the Forum the chief buildings of Rome were grouped, and when the mighty city was in her glory they must have been an imposing sight.

Roman architecture included enormous walls, bridges, aqueducts engineering feats; it covered a great diversity of buildings—temples, tombs, basilicas, or public halls, palaces, baths, circuses, theatres and amphitheatres.

THE PILLARS AND ARCHES THE ROMANS BUILT FOR GLORY'S SAKE

There were smaller architectural works, like triumphal arches, pillars of victory, and fountains. The arches and pillars they built for glory's sake, to commemorate the greatness of their emperors and generals. In Rome there were the Arches of Titus, Constantine, Septimius Severus; at Ancona the Arch of Trajan, and another at Beneventum, in southern Italy. The arches were either single or triple, adorned with sculptured reliefs; their piers faced with Corinthian or Composite columns. The Marble Arch, London, is of the triple-arch kind, built in imitation of the Roman.

Of the Pillars of Victory, Trajan's column at Rome, a Roman Doric pillar 115 feet high, freely sculptured, is the most famous. Around the shaft, like a spiral band, runs a winding relief, telling the tale of some of Trajan's exploits. A statue of St. Peter now stands on the top of the pillar in place of that of the Roman emperor. In the Victoria and Albert Museum, South Kensington, London, is a plaster reproduction of the Trajan column. Another famous pillar was the Marcus Aurelius column, similarly decorated.

The Romans built fountains in great numbers. There were hundreds of them, public and private, in their cities. They erected them partly out of their love for running water and the coolness of the tossing sprays from the fountain's jet, and partly in memory of municipal events and distinguished persons.

There was only a certain amount of marble to be had by the Roman builders. But they had plenty of terra-cotta, stone and brick. And early in their development they invented a new material, concrete, whose appearance is a landmark in the history of building construction.

THE MANY USES THE ROMANS MADE OF CONCRETE

We know from existing portions of the Roman Wall in London how enduring their concrete was. It consisted of a mixture of lime and a peculiar sandy earth called *pozzolana.* Once they had discovered its granite-like qualities, the Romans used their concrete freely, not only as a strengthening substance, but as a building material itself. They made walls, domes, vaulted roofs of solid concrete, or concrete with brick ribs, and faced the structure with marble, brick or mosaic. This use of concrete has served as a model to builders down through the centuries to the nineteenth, when steel came into use.

As masters of the new medium, the Romans became independent of local conditions in any new, conquered country.

Concrete and bricks could be made anywhere; in nearly all lands there was native stone. Thus it happened that their construction was practically the same all over the empire.

The Romans are intensely interesting as builders, even if they were not great artists in architecture. Their construction was what one would expect from so strong a people. Whether it be fragments of walls or patches of mosaic—wherever anything Roman is delved out of the earth it becomes an object of envy to the modern builder. The watchword of the Imperial architects was: "To Endure." Hence that saying, "When falls the Colosseum, Rome shall fall."

After the lapse of time these great people are remembered most for their engineering works and for their domed and vaulted temples. It was natural to them to erect huge buildings. They must have been conscious of the greatness of Rome when they flung up the great dome of the Pantheon. It is interesting to note that stupendousness in architecture like that of the East came into Europe by way of the Romans.

The Pantheon, which is now a Christian church, is the most wonderful temple Rome produced. It is the earliest domed building of which any trace remains, and, being in a good state of preservation, is a guide to Roman architecture of this kind.

THE WONDERFUL OPEN DOME THAT CROWNS THE PANTHEON IN ROME

The entrance, a magnificent portico of Corinthian columns, with a sculptured pediment, must have reminded the Romans of the Greek temples they so admired. But behind these ranked columns, over the rotunda, or circular hall, rose something Greek architects never thought of: a huge round dome where light is spilled through one great central hole in the roof. When the Pantheon was in its glory of color and gold and all the enrichments of its artists, the effect of this "eye of heaven" shining down aslant the dome must have been glorious and awe-inspiring.

Among the other sacred buildings which inclosed a polygonal or a circular dome were: the Temple of Vesta at Rome, the earliest and most sacred of them all, built about 715 B.C.; another to the same goddess at Tivoli; the Temple of Jupiter at Spalato; and that of Venus at Baalbek, in Syria. Of their many rectangular temples resembling the Greek, the best preserved and finest example is a building now called the Maison Carrée, at Nîmes. Another fine one, which has suffered at the hands of time and enemy peoples, like most of the temples of this class in Italy, was the Great Temple at Baalbek. Within all the public buildings, sacred and secular, stood a great array of Greek statues, pillaged from their home.

Of their palaces, basilicas and public baths, only ruins remain, and we cannot but deplore the loss of such characteristic buildings of a great people. The baths were colossal. One writer has described them as towns in themselves, with their corridors and halls for exercise and rest, and their gardens, all grouped round the chambers of the bath. Here the luxuriousness and grandeur of the Roman displayed itself. We can best visualize them by imagining the apartments of ordinary Turkish baths built like a palace for grandeur.

THE TOWN THE ROMANS BUILT WITHIN THE WALLS OF A PALACE

This same sense of largeness strikes us when we think of their palaces—of the group on Palatine Hill, Rome, partly excavated, imposing even in ruin, and the palace at Spalato, in Dalmatia, within whose walls a town was afterward built.

The basilicas were large halls where commerce was carried on and courts of justice held. They are interesting to us now as forming a link between pagan and Christian architecture. On their model were built the first imposing churches of the early Christians.

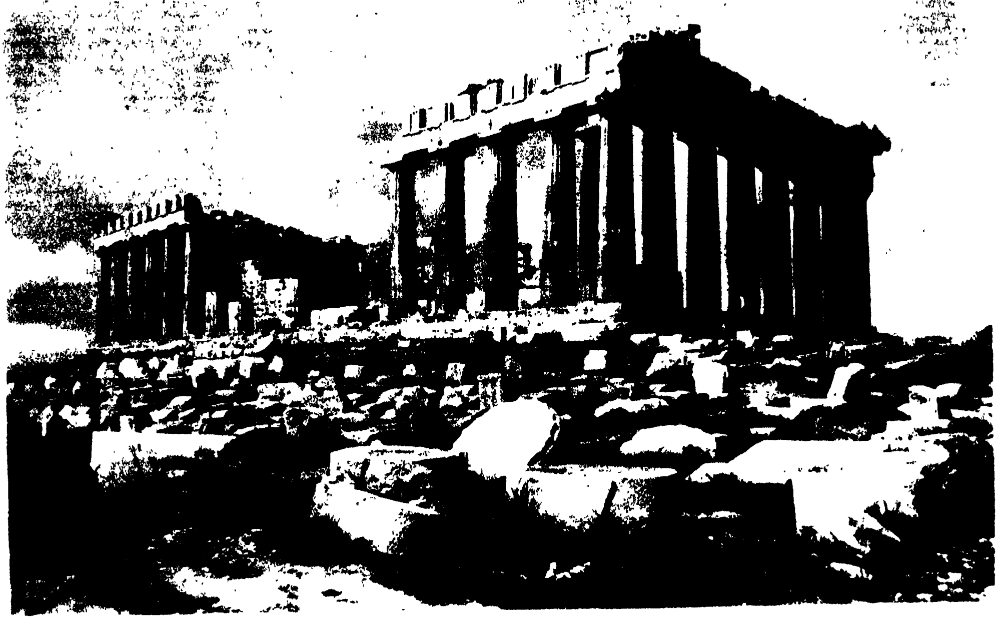
Of the Roman theatres there are interesting remains at Orange, in southern France, in Rome and in Athens. They were built somewhat on the lines of the Greek theatres. One of the differences lay in apportioning the central part, which had been assigned to the Greek chorus, to Roman dignitaries and various other important persons.

Amphitheatres were a Roman invention—very characteristic of a martial, active people who gloried in physical exploits. Hence their gladiator shows, whose tradition remains in the Spanish bull-fights of to-day.

The Colosseum, built the first century after Christ, was the greatest of these amphitheatres. Another fine amphitheatre is in partial ruin at Verona.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 5468.

BUILDINGS OF GREECE AND ROME



THE PARTHENON AS IT STANDS TO-DAY ON THE ACROPOLIS OF ATHENS

THE PROPYLÆA—THE APPROACH TO THE ACROPOLIS OF ATHENS

THE NORTH PORCH OF THE ERECHTHEUM ON THE ACROPOLIS

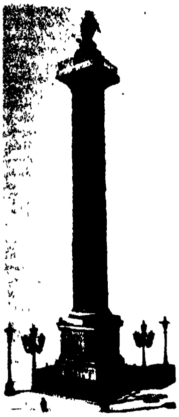
THE CHORAGIC MONUMENT OF LYSICRATES AT ATHENS

THE TEMPLE OF THE WINGLESS VICTORY ON THE ACROPOLIS

THE TEMPLE OF THE OLYMPIAN ZEUS AT ATHENS

THE GREEK BASILICA AND TEMPLE OF POSEIDON AT PÆSTUM, IN SOUTH ITALY

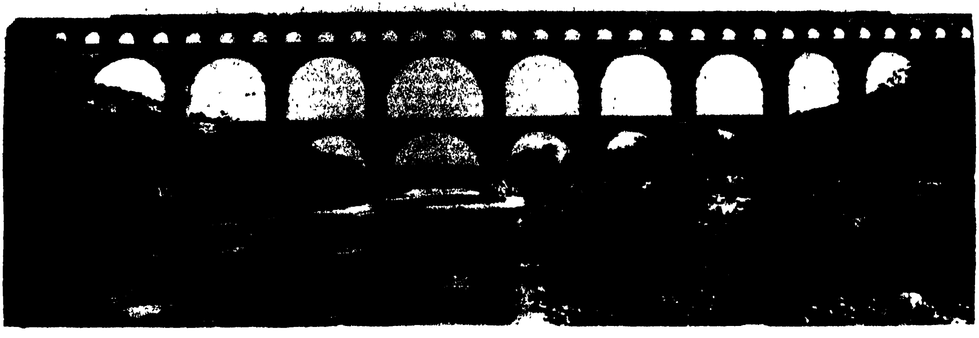
COLUMNS OF THE TEMPLE OF CASTOR AND POLLUX AT ROME



THE COLUMN OF MARCUS AURELIUS AT ROME

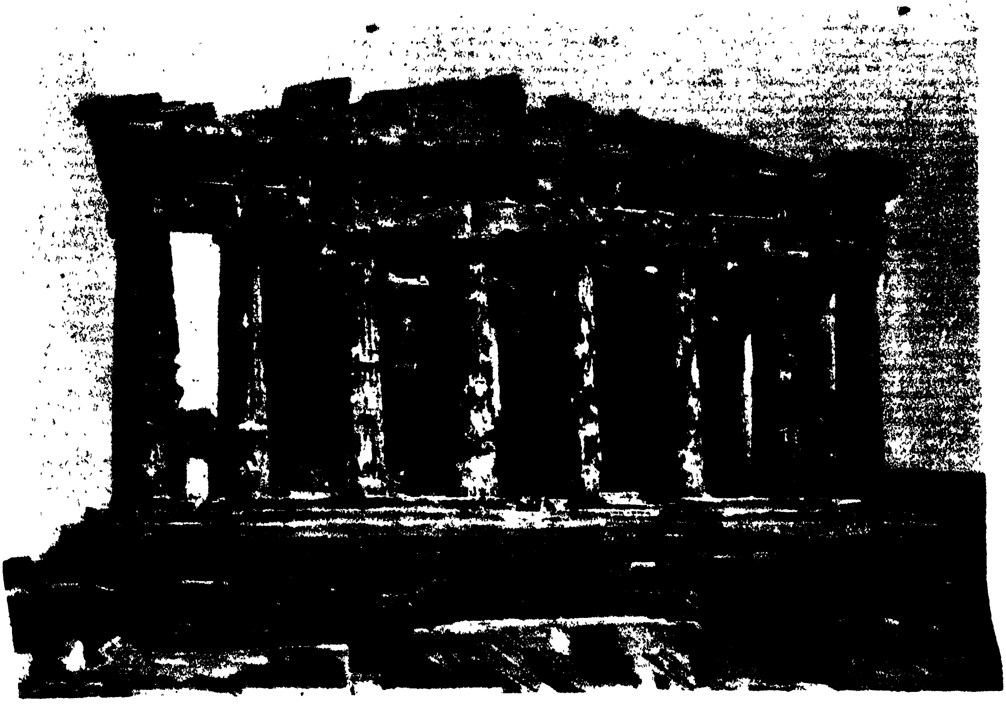
A LITTLE TEMPLE AT TIVOLI, A FEW MILES OUTSIDE ROME

THE BEAUTIFUL MAISON CARRÉE AT NÎMES

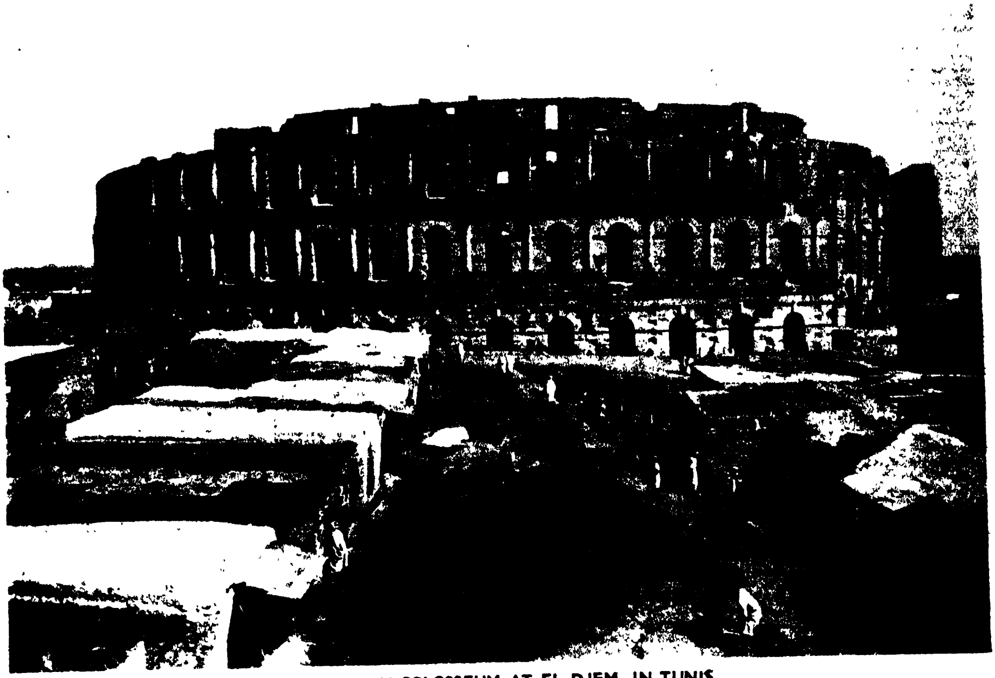


THE PONT DU GARD, THE MARVELOUSLY PRESERVED ROMAN AQUEDUCT AT NÎMES, IN PROVENCE

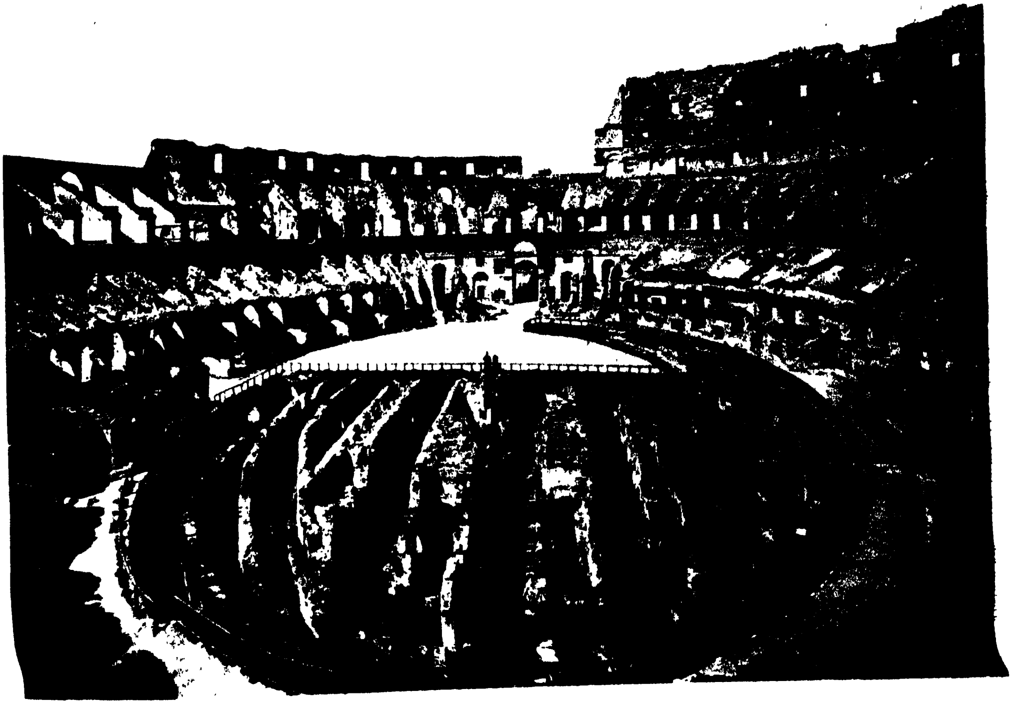
THE GREEK TEMPLE OF CONCORD AT GIRGENTI, IN SICILY



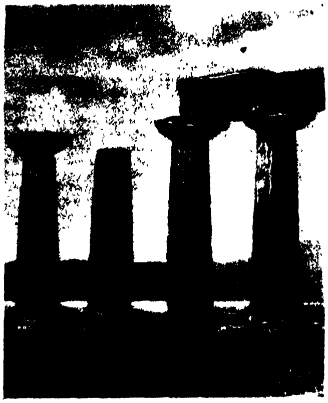
THE DORIC COLUMNS OF THE PARTHENON

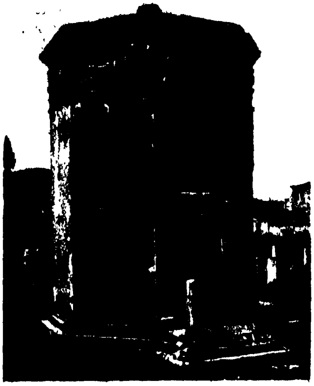


THE ROMAN COLOSSEUM AT EL DJEM, IN TUNIS

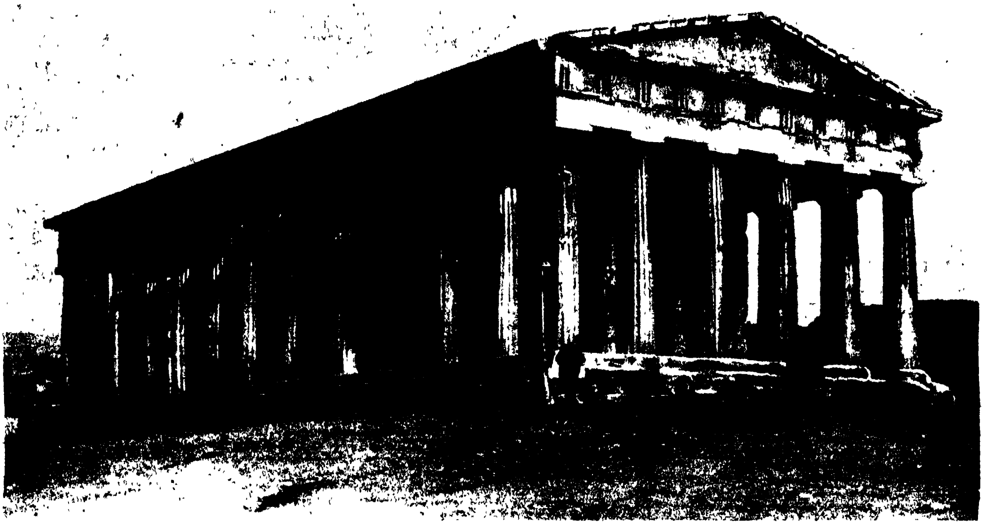


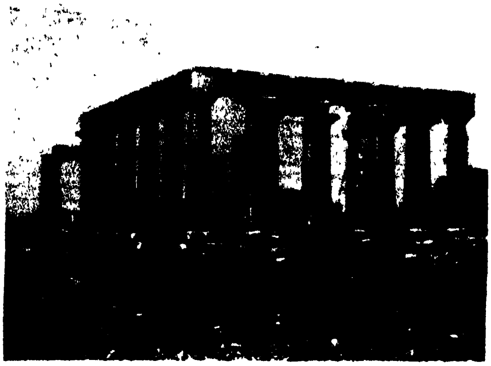
THE INTERIOR OF THE GREAT COLOSSEUM AT ROME

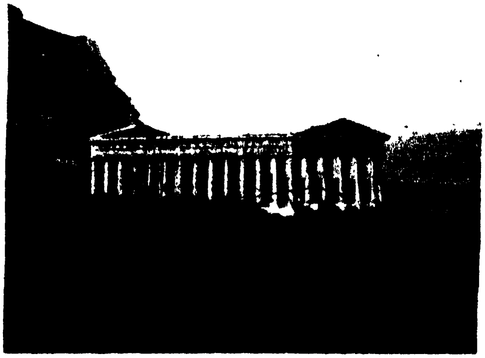

COLUMNS OF THE TEMPLE OF APOLLO AT CORINTH

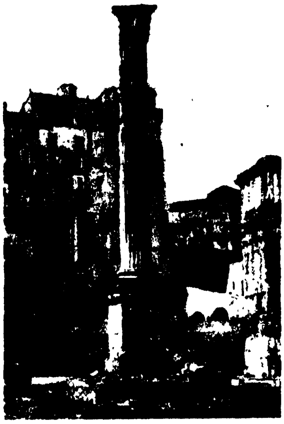

THE TOWER OF THE WINDS AT ATHENS

THE TEMPLE OF NEPTUNE AT SUNIUM


THE THESEUM AT ATHENS, THE BEST PRESERVED BUILDING OF ANCIENT GREECE


THE TEMPLE OF APHAIA AT ÆGINA

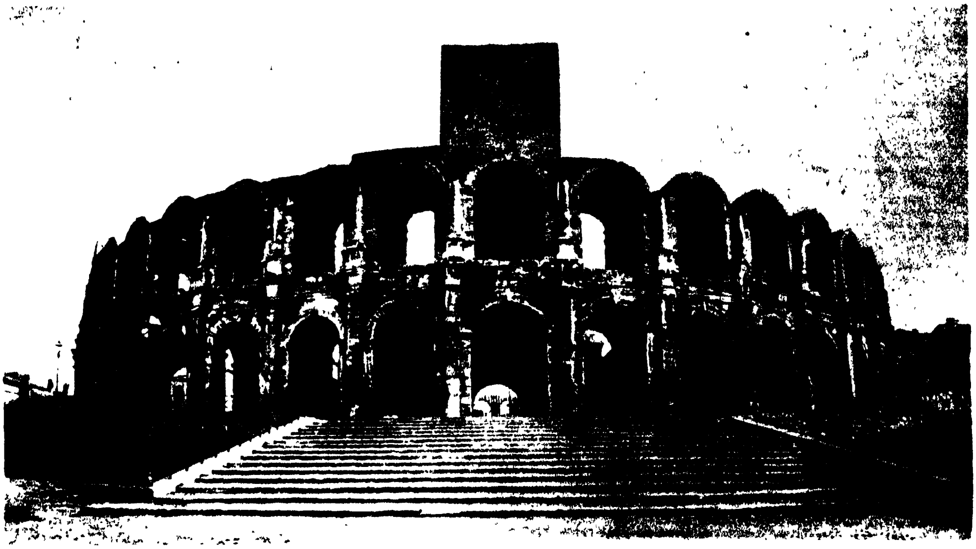

THE OLD GREEK TEMPLE AT SEGESTA, IN SICILY



THE COLUMN OF PHOCAS IN ROME

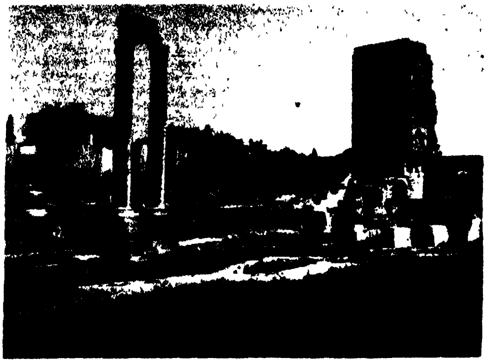
THE ROMAN CORINTHIAN TEMPLE OF BAAL, IN SYRIA

COLUMNS OF THE TEMPLE OF VESPASIAN, ROME

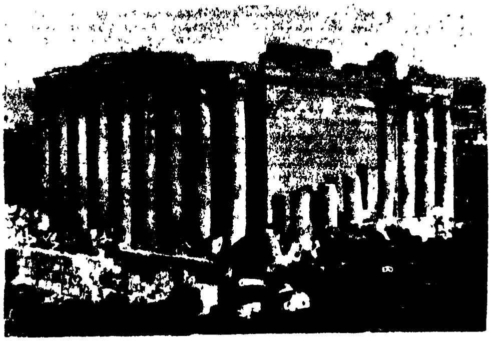


THE GREAT ROMAN ARENA AT ARLES, IN PROVENCE

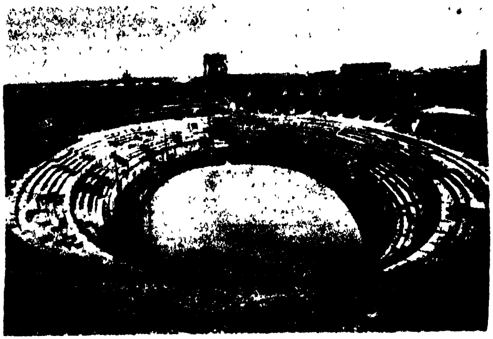
A ROMAN BRIDGE AT PERGAMUM, IN ASIA MINOR



THE ROMAN THEATRE AT ARLES



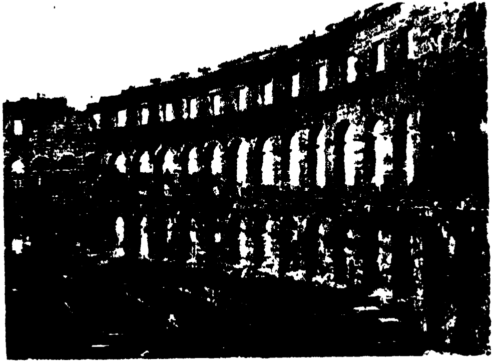
THE TEMPLE OF BACCHUS AT BAALBEK, IN SYRIA



THE INTERIOR OF THE ROMAN ARENA AT ARLES

THE COURTYARD OF THE HOUSE OF THE VETTII AT POMPEII

THE ARCH OF SEPTIMIUS SEVERUS, AT ROME



THE AMPHITHEATRE AT POLA

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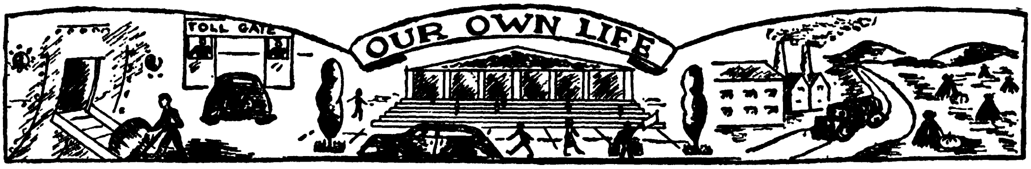


HOW WEALTH IS CREATED

WEALTH has been defined as a collection of things limited in supply, transferable, and useful in satisfying human desires. We may go further and say that wealth to most of us means possession of things over and above the amount needed for bare living from day to day. A country has wealth if enough of the people have a good store of sound money or other possessions. A country has potential, or unused, wealth if it has stores of minerals or forests or other gifts of nature that have not yet been worked.

Wealth is created through what the economist calls the process of production. Production takes place when a commodity is shaped into a desired form, taken to a place where it is wanted at a particular time, and purchased by a consumer who believes it will satisfy some particular want. For example, the wheat farmer raises the grain, the miller changes it into a useful form—flour—the railroad carries the flour to a place where it is wanted, when it is wanted, while the merchant performs the service of getting the flour into the hands of the baker or the housewife who converts it into bread for immediate consumption. All these people are producers. So you see that anyone who makes a commodity more useful is a producer. If in doubt as to whether any person is a producer or not, just ask the question, is someone willing to pay for the product he turns out or the service he renders? If the answer is yes, then he is, according to economics, a *producer.*

From the beginning of time man has secured a living from the soil. For ages, even to exist meant a continuous struggle. Existence was possible through the combined forces of two *productive factors,* or agents—*nature,* or *land,* and *human labor.* With the long passing of time, a new and very important factor in production appeared—*capital.* Later as the Industrial Revolution spread

Many hands make light work. Modern factories employ thousands of workers, and produce goods in great quantities.

from Europe to other parts of the world, a fourth factor became very important. To this new factor is given the name *enterpriser*. Now let us see the part played in production by each of these factors and why each is so important in modern economic life.

1. *Land,* or *nature,* is that which provides us with standing room in which to work and play, materials and forces. In the science of economics, land means far more than just soil. It includes, as used in this broad sense, everything above the earth, as air; everything upon the earth, as soil, trees, rivers and lakes; and all that is under the earth, including rocks and minerals. When we include forces in our definition of land, we are referring to such things as electricity and the law of gravity. In economics all these things are included under the term *land*.

2. *Labor.* By labor, as a factor of production, is meant the application of our mental and physical powers to the materials and forces of nature in the creation of economic goods or wealth.

Labor is usually considered as of two kinds, physical and mental. The physical workers are likewise divided into two classes; the unskilled, as the pick-and-shovel worker, and the skilled worker, as the shipbuilder, boiler-maker and automobile mechanic.

There are also two groups of mental workers. First, the *routine* worker, such as the average bookkeeper or store clerk. Second, there is that much smaller, though very important, group known as the *inventive* class of labor. To this class belong the expert accountant, the store manager and your school principal, as well as such men as Eli Whitney, who invented the cotton-gin, and Thomas Edison.

It is not the amount of labor we do which creates wealth, but its effectiveness. Man is a small creature, much weaker than many of the higher animals, but his muscles are directed by his wonderful brain. It is a common error to speak of labor as the source of wealth. The truth is that all the labor in the world would be of little use unless it was used in co-operation with the other factors of production—land, capital and management. It is equally true that wealth increases, not by increasing labor, but through saving labor.

As long as man worked with his own

Virginia State Chamber of Commerce

Physical labor is generally divided into two classes, skilled and unskilled. Here we see unskilled labor.

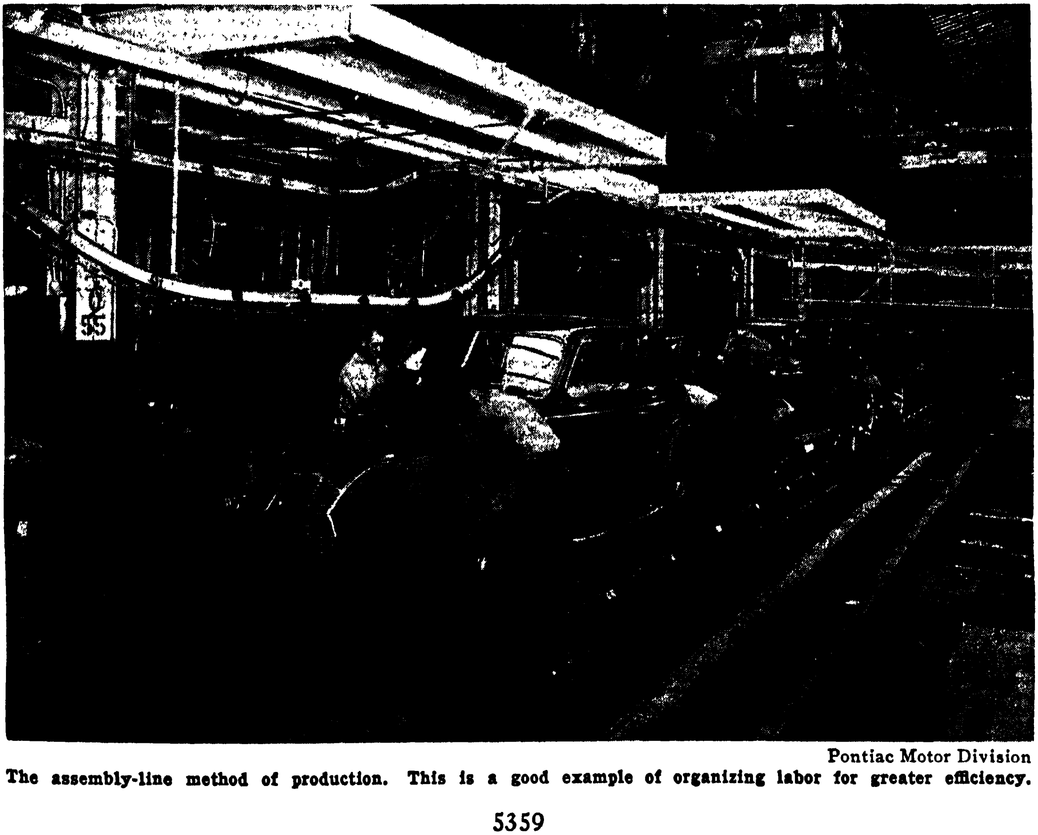
hands, or with the aid of a few simple tools and weapons, he spent nearly the whole of his life in obtaining a scanty supply of food. No matter how rich the territory he inhabited, he could not become wealthy, or enjoy much comfort or culture. A striking example of this is the United States, which supports about 140,000,000 people. Not very long ago in the world's history, this territory, with all its wonderful wealth of rich prairie land, timber, fine rivers, natural ports and magnificent stores of animals, was the home of a small number of men, most of whom hunted or fished or scratched for a scanty living, and failed to create wealth because they did not know how to make the best of the natural gifts about them.

But when labor is aided by the inventions and discoveries of clever men, and exercised in a properly organized way, the possibilities of wealth production are almost unlimited. We of today are very fortunate; we are the heirs of all the ages—the inheritors of the work and genius of every great man and woman of every nation. We have a greater opportunity than ever to create more wealth.

Now here is a remarkable thing. The great inventions and discoveries in history have been the work of a few gifted people. Even if we include the small inventions, the number of people to whom we are indebted for the modern means of making wealth amounts to a tiny fraction of the billions who have lived on earth. If we are ever tempted to be proud of using such inventions as the electric light, or the railway train, or the steamboat, or the radio, let us remind ourselves that we did nothing to bring them about, and that we can at least use them intelligently.

We have seen how labor is divided between individuals, between trades, between territories and between nations, in such a way as to get the best results. By organization we can make ordinary people as effective for many purposes as if they were very clever indeed, while we can raise the value of all the people concerned, whether individually clever or not.

Suppose a man invents a tool. If he remains the sole user of the tool, the value of his clever brain is confined to the one possessing it, himself. If, however, he shares the secret of his tool with others, each one


Pontiac Motor Division

The assembly-line method of production. This is a good example of organizing labor for greater efficiency.

Prudential Insurance Co.; Handy and Bosser, photographers

The automatic electric typewriter is a helpful labor-saving device.

who has it at once becomes a clever worker, by use of a tool he could not have invented for himself. So men become, as it were, clever at second hand.

3. *Capital* is produced wealth used in the production of other wealth. From this definition it can be seen that all capital is wealth, but that all wealth is not capital. Land is wealth but certainly it is not capital. That is because land is not produced, it is a gift of nature. Capital is the result of human effort, requiring both waiting and sacrifice.

The following story may illustrate what we mean. In early times, a man might have kept his family fed by fishing all day long with hook and line. But one day he might have taken time to build a net, while living on half-rations for the day. Going out the next morning he would find that within the space of a few hours, by means of the net, he could catch far more fish than he had caught previously by working all day. Through sacrifice and waiting, capital was created in the shape of a net. The farmer who puts aside a portion of one season's income in order to buy a new plow is creating capital in the very same way. He buys the plow in the belief that spending his money for it will result in increased production.

Capital has vastly aided human progress. We have seen how inventions have multiplied the powers of man, making men, even if not clever themselves, the users of clever things. It must be understood, however, that if someone did not take the trouble to store up capital in the shape of machines and inventions, the inventions could not be used.

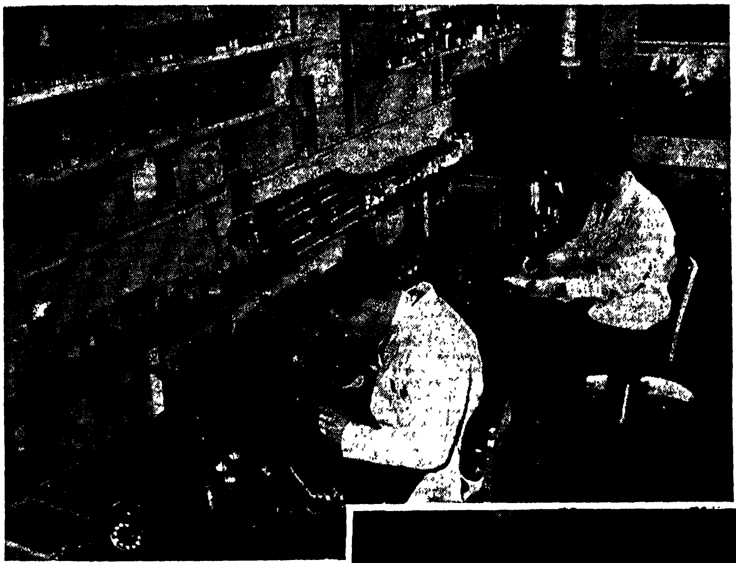
Suppose someone invented a cheap method of extracting from clay the shining white metal, aluminum, which it contains. That would be a tremendous service to mankind, because aluminum is not only beautiful but useful. Such an invention would make a very great difference to the powers of men, and we could use aluminum for many new purposes. However, the new process could not be used unless somebody found the means to set up the inventor's clever machinery. Someone must find the capital to utilize the new invention, or the invention does no good.

Let us consider the railroad that passes through the city or town in which you live. A train is a marvelous thing, though most of us are so familiar with trains that we feel no astonishment at seeing a great locomotive drawing a long procession of cars over the rails. A number of clever brains thought out the ideas which are used in making a modern train. Stephenson invented the railway engine; Westinghouse invented means of checking the speed of a train by air brakes; Pullman gave us the modern dining and sleeping cars. Perhaps a hundred other inventors improved upon the basic designs; and millions of people every year ride on the railroads. Many enjoy the inventions of a few.

Yet, no matter how clever the ideas, the railroad could not have been if some people had not stored up money to manufacture locomotives and trains, to erect buildings to hold engines and cars when not working, repair shops, tracks and ties, and offices in which to control the whole undertaking. These things form the capital of the railroad. They embody the inventors' ideas. Once more we see that labor becomes fruitful when capital makes it possible to put inventions to work.

Remember, it is the saving of work which results in capital. The Eskimo's sledge, his dogs, his canoe, his knife are his humble capital, or stock. These are the result of his careful saving, and if he did not thus save he would perish.

The principle is the same in civilized communities. We have learned to exchange goods with each other by means of *money*. By money we measure the value of things by a common standard, and money enables civilized men to save up work in a convenient way. Money acts as a *storer* of value. Instead of saving up hats, if we make hats—or automobiles, if we produce automobiles—we can save up money. The money we can either use ourselves or lend to others, to establish stocks of capital with which to use inventions, and to enable persons to be employed in working on inventions.

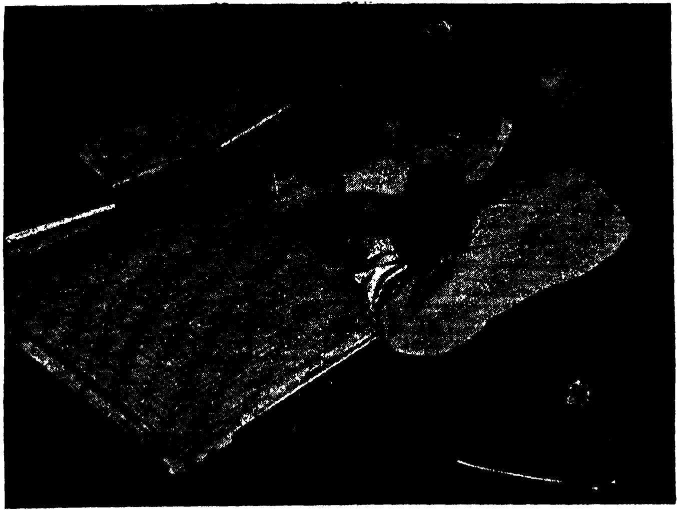


Hercules Powder Company
Scientists are mental laborers.

Thus *saving* becomes very important, for without it all the clever inventions of machines and appliances would be useless. It would have been in vain for Watt or Stephenson to invent the locomotive if people had not been found willing to lend money to make enough engines to run a railroad. It would have been in vain for men to invent radio if enterprising and saving people had not come forward to put their money into broadcasting stations and equipment, through which programs are brought into your home, and may reach every corner of the world. Now we see clearly what capital is. It is a stock of *produced goods* resulting from saving; and if no one saved, there could be no capital.

The person who saves and owns capital is sometimes called a capitalist. He may be either a man who has saved to form a business which he himself will organize, or he may be one who, having nothing to do with the business himself, has lent the money required to buy the machinery, equipment and raw materials needed to run the business.

4. The *enterpriser* is the fourth factor of production. Before the Industrial Revolution, the factors of production were not separately owned. One man owned the land and provided the labor and the capital to carry on his business. Most of what a family consumed was produced at home. Problems of labor and capital were absent.



Bell Telephone Company
Draftsmen, like scientists, are mental laborers who sell their skill.

Australian News and Information Service

This savage fisherman is attempting to spear his supper. His only equipment is a primitive dugout canoe and crudely carved prong spear.

However, with the coming of machinery, one person came to have labor to sell, another land to rent, and still another capital to invest. These factors were unorganized until the *enterpriser,* or business man, assumed the task of unifying them in order that production might be properly carried on. The enterpriser assumes the risks for the success or failure of the business. He must make the decisions as to the amounts of land, labor and capital necessary in a given plant or industry.

This co-ordination of factors may be more clearly understood by studying a large corporation, as for example, a great telephone company. The wires, switchboards and buildings represent the capital. The land provides the space for buildings and equipment. The managers, linemen and operators represent the labor factor. The stockholders and their chosen officers constitute the enterprisers upon whom the final success of the industry rests. They are the ones who receive what profits are made, and they are the people who must shoulder any losses.

This illustration should make it clear that no one factor in production is more important than the others. In any industry the combined factors must work together smoothly and in proper proportions. Any attempt to place greater importance upon one factor, as for example, capital, or labor, would be about as difficult as to try to determine which cutting edge of a pair of scissors does the cutting, or which leg of a three-legged stool is most important.

As we have seen, the *enterpriser* is a man with imagination. He recognizes a business opportunity others neglect. He may be a Ford, who first saw the importance of a low-priced automobile; a Firestone, who developed the rubber industry; a Woolworth, who recognized the opportunities in five-and-ten-cent stores; or perhaps your father, who was the first to sense the need in your home town for another bank, a new store or a particular manufacturing plant.

No matter what the field of activity, the enterpriser is successful if he succeeds in producing a commodity or rendering a service for which the people are willing to pay a price high enough to return a profit. He is the one who organizes the productive factors into what the economist calls a business unit, which has as its purpose the making of profit through the production of wealth.

The business unit may take any one of three forms: (1) the sole proprietorship, (2) the partnership, or (3) the corporation.

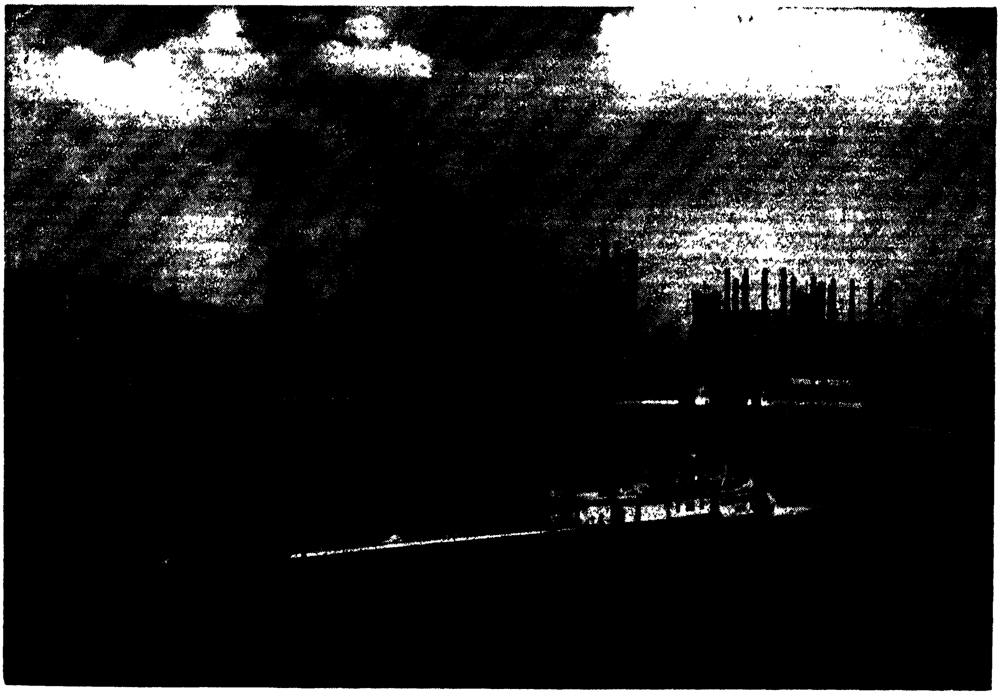
1. *The Sole Proprietorship* exists when one person organizes, manages and takes full

responsibility for the success or failure of the business. He must provide the land and the capital, hire the labor and direct all the productive operations. By far the greatest number of business organizations are of this simple type; yet it accounts for only a small proportion of the capital invested in business and the number of laborers employed in the United States.

The very fact that the sole proprietorship is easy to organize has made it popular. There are no complicated legal requirements to be fulfilled, or payment of heavy fees to the state. The sole proprietor also knows that the harder he works the more he is likely to earn, and that all the earnings go to him. There are no partners or stockholders with whom he must share his earnings. Finally, there is no red tape connected with the operation of the business. Suppose, for example, one of your neighbors owns and operates the leading clothing store for men in your community. He is perfectly free to buy as large or as small a supply of suits or shirts or ties as he wishes. He may spend money for advertising as he thinks best, extend credit to customers or require cash, open and close the store at will, and even go out of business solely on the basis of his own judgment. In short, he is his "own boss."

He does, however, face some serious disadvantages. In case the business fails he is held liable for all the debts. All his personal savings and possessions may be taken over to pay rent and wages that are owed and for the merchandise he has bought from the wholesalers. Another disadvantage is the difficulty of getting together large amounts of capital. Rarely can a business man by himself secure sufficient funds to enter business on a large scale. This may prove a great handicap when competition is keen, or in periods of depression when reserves are necessary to tide the business man over the slack period when trade falls off and not enough money is coming in to meet his current costs of staying in business.

2. *The Partnership.* A partnership exists when two or more persons by mutual agreement organize, manage and assume the risks of business. It is customary for those forming a partnership to draw up a written agreement, setting forth the terms upon which the business will be run, the amount of money or capital each will put into it,

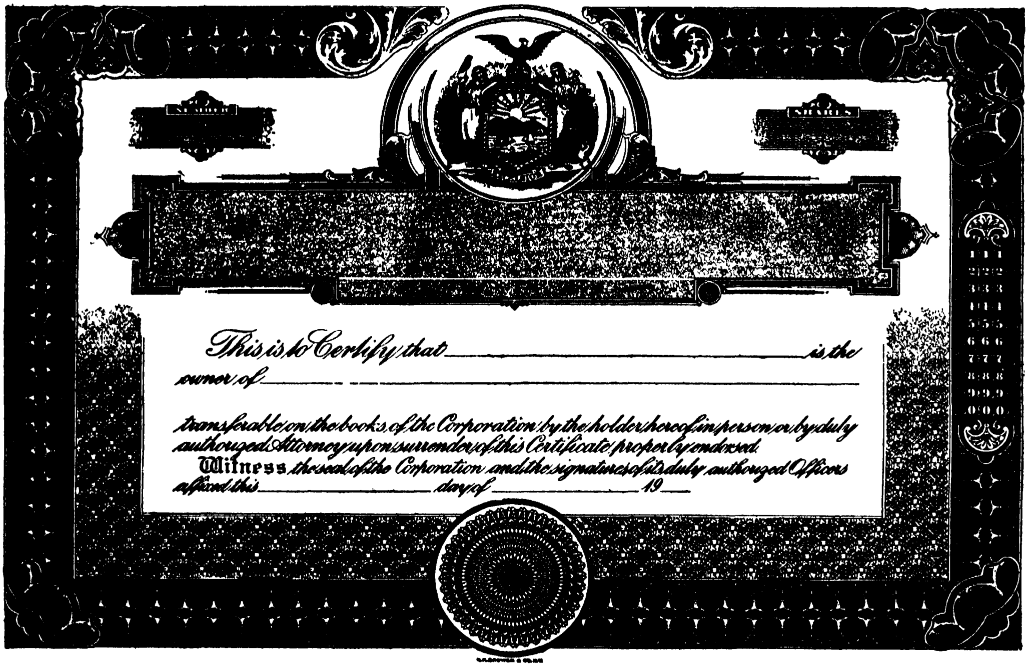


United States Steel Corporation

The big iron and steel companies depend upon a great number of inventions, and employ all classes of labor.

and how the future profits are to be divided up among the partners.

This type of business unit has certain advantages over the single proprietorship. To start with, it is easier to get the necessary capital. Where two or more business men join together in a business undertaking they are usually able to pool a much larger sum of money for business purposes than could the sole proprietor. There is also the added advantage that comes from pooling their abilities and judgment. You know the old saying: "Two heads are better than one."



This is to Certify that ______________________ is the owner of ______________________

transferable on the books of the Corporation by the holder hereof in person or by duly authorized Attorney upon surrender of this Certificate properly endorsed.

Witness the seal of the Corporation and the signatures of its duly authorized Officers affixed this __________ day of __________ 19__

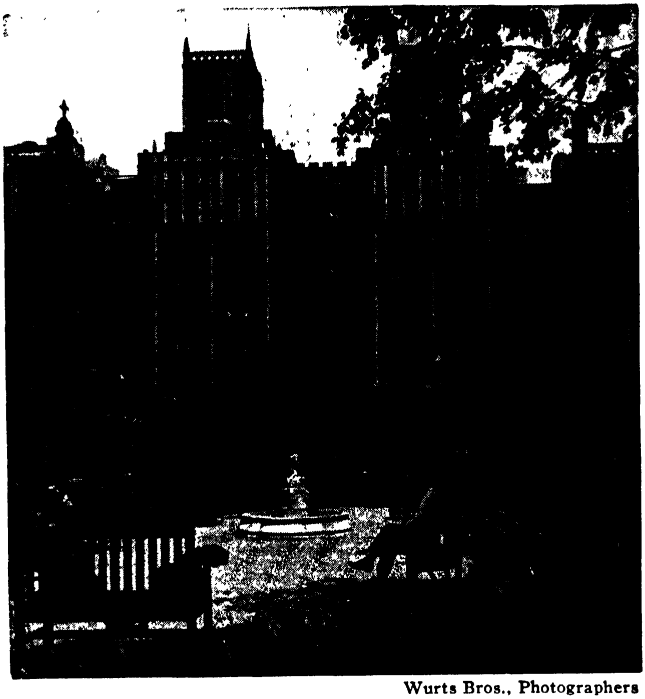
A stock certificate entitles the holder to a share in the profits of the corporation which issues it.

The greatest drawback to the formation of a partnership appears when such a business venture fails. Then each one of the partners is held individually liable for the total liabilities of the partnership, in case the other partners are not able to assume their share of the debt. This could, of course, completely ruin a person and place on his shoulders a debt which could prove a lifelong burden.

The partnership is popular as a form of business organization with small merchandising firms, in the trades, and among doctors and lawyers. The next time you go downtown, look at the signs above the shops and offices you pass. No doubt you will be surprised at the number which read something like this: Smith and Smith, Hardware Store; Jones and Brown, Grocery; or Graham and Hirsh, Lawyers.

3. *The Corporation.* Most large businesses and many small ones prefer to organize as corporations. A corporation is an imaginary or artificial person created by law for some particular purpose. That is, under the law the corporation has the same rights and privileges as does an individual. The persons who own the business are not the corporation, but merely represent this legally created individual, and carry out the rules and regulations which the state grants the corporation at the time of its creation. The privileges are granted in the *charter* which is received from the state in which the business is incorporated.

The corporation raises money for organizing and carrying on a business in two ways. First, through the sale of stock, which is a share or interest in the corporation. If, for example, your father should buy a share of stock in the telephone company, or a local bank or factory, he would receive a receipt for the money he paid. This receipt would be a piece of paper stating the number of shares your father bought on a certain date,



Wurts Bros., Photographers

Our houses are a combined product of capital, management and labor.

and bearing his name as owner. Such a receipt is called a *stock certificate*. Ask your father if he owns such a certificate; if he does, ask him to let you see what it looks like.

Many people do not wish to risk their savings in the purchase of stock. For them a much safer investment is offered in the form of bonds. A bond is a note of a corporation given in return for a loan of money, pledging to return the money at a stated future time, and also agreeing to pay a certain rate of interest at regular intervals, usually twice a year. Most large corporations at some time or other use this method in order to raise additional money for carrying on the business. National governments also use this method to secure funds when more money is needed to carry on the government than is raised by taxes.

The corporation form of business organization enjoys several distinct advantages, the most important of which is *limited liability*. This means that if the business should fail the loss to any stockholder is limited to the amount invested. He can not, as in a partnership, be compelled to make additional payments in order to meet any outstanding debts. Another advantage is to be found in the ability of the corporation to gather together much larger sums of money for organizing and operating the business.

An excellent illustration is provided by the American Telephone and Telegraph Company. Its capital investment amounts to many millions of dollars. Yet to share in these profits a person need buy only one share of stock costing less than two hundred dollars. This shows how many people may each place a small amount of money in a corporation and so create a large capital fund with which to do business.

The major disadvantage of the corporation is that the holder of a share of its stock must assume the risk of losing what he paid for it. This is the chance he takes. Over and against this risk, of course, is the possibility that he may receive very large profits. Unless a person can afford to lose his investment, he should not purchase stock.

We have just seen how the arrangement of the factors of production in such a fashion as to make them fruitful is a very important thing, and not every one has the gift of happy arrangement. We owe a good deal to these enterprisers who can organize and put into work the best processes and inventions.

Organization and invention between them save work, and in saving it, set labor free to do other work. This is a most important economic truth. For its neglect we pay in poverty and distress.

Let us think of a hundred people working on an island and entirely dependent on their own labor. If the labor of all the hundred is needed to find enough food to keep them alive, that food is their sole wealth. They can possess nothing more, because all their efforts are needed to feed themselves, and they must eat or die. Therefore, in such case, they can not have clothes, or houses, or furniture, or any other comforts.

But suppose clever ones among them invent good weapons with which to hunt—weapons so effective that only fifty people are needed to feed the hundred islanders. In that case the work of fifty food-getters is saved, and therefore fifty persons are set free to do other jobs. The fifty, being freed, can set to work to construct huts and make garments. The little community becomes richer, not because more work is done, but because a particular form of work has been saved.

Suppose the fifty remaining food-getters, by further inventions, become twenty-five. Then twenty-five can produce the food needed by the hundred islanders, and seventy-five are free to do other work. The islanders become richer *because work has been saved.*

This process of *saving labor* is just as true in a great nation as on the little island we have imagined. A nation can become richer only by means of organization and invention continuously *setting labor free* to do fresh work. That is why the idea of making work is a fallacy—a deceptive thing. Sometimes workmen are tempted to think that if they spin out a piece of work, or refuse to use a labor-saving machine, they will make more work for others. The very reverse is the truth. It is only by saving work, by using inventions as freely as possible, that we can make things better for other people. He who makes work, in the sense of taking an unnecessarily long time to produce a thing, makes poverty. He who saves work, in the sense of producing as quickly as possible and as much as possible with the least amount of labor, creates wealth and employment.

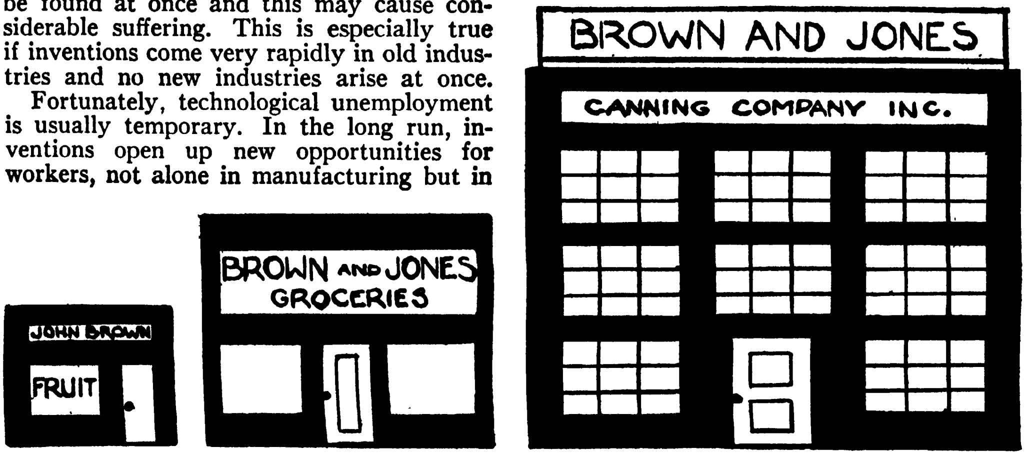
It is quite true that a machine which saves labor may throw men and women out of work for a time. This is sometimes called technological unemployment, which means that people are unemployed through no fault of their own. Other work for them may not be found at once and this may cause considerable suffering. This is especially true if inventions come very rapidly in old industries and no new industries arise at once.

Fortunately, technological unemployment is usually temporary. In the long run, inventions open up new opportunities for workers, not alone in manufacturing but in other occupations as well. For example, back in 1900 about one million persons were employed in jobs closely related to the horse and buggy. However, with the coming of the automobile, the carriage and wagon makers, the local blacksmith, harness-maker and feed-store owner were put out of business. These were examples of technological unemployment. But as a result of the rapid growth of the automobile business by 1938, those engaged in producing, selling and servicing the automobile employed almost 6,500,000 persons. Likewise, throughout this entire period rapid technological strides were being made within the automobile industry itself. Instead of destroying jobs they created many new ones. This is but one of many examples that you may discover to show that by the use of labor-saving devices both wealth and employment are increased.

Thus we have examined four things, which we speak of as Land, Labor, Capital and the Enterpriser, the four chief factors in the production of Wealth. Land, as covering all the gifts of Nature, which man may either use or neglect; Labor, as covering all human effort; Capital, the saved stores without which our labor is in vain; and the Enterpriser, who gathers the other three factors together and puts them to work in the proper proportions so that they may produce most efficiently. Because these factors of production have worked together so efficiently over the years, the people of the United States and Canada have more wealth and a higher standard of living than those of any other country in the world.

By GRAEME O'GERAN.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 5589.



Left: John Brown, sole proprietor. Center: Brown in partnership. Right: Brown and partner form a corporation.

SCIENCE

Photo by Harold K. Whitford

The campfire around which these Boy Scouts are gathered provides an example of what chemists call oxidation.

CHEMICAL BEHAVIOR

IN chemistry we are interested in finding out how the various materials in our universe are put together. We learn how two or more different substances can be made to combine to form an entirely new substance, or how a single complicated material may be separated into different, simpler substances. And we learn how a number of materials will change in time, even though nothing appears to be done with them, or to them.

In this way chemistry is different from physics, as the following illustration will show. If we take some fine iron filings and powdered sulfur, and mix them together thoroughly, the physicist could still separate them very easily by using a magnet. The iron would stick to the magnet, and the sulfur would not. But now suppose we heat up the mixture until the iron and the sulfur begin to *react* with each other, as we call it in chemistry. When this reaction is finished we have a chemical compound, instead of a physical mixture. We can no longer separate the iron from the sulfur with a magnet or with anything else. What has happened is that the separate particles of iron and sulfur, their atoms, have joined into a molecule of iron sulfide, a new substance, with properties entirely different from those of either iron or sulfur.

This is one of the simplest examples of what is called synthesis, a Greek word, meaning "putting together," used in chemistry to describe the building up of complex substances from simpler ones. Industry does a great deal of this kind of work. You are familiar with the terms "synthetic rubber," "synthetic dyes" and many other synthetic substances.

We can also do the opposite thing. If we take a piece of limestone and heat it up, it will fall apart into two simpler substances, a very light white stone, quicklime, and a gas, carbon dioxide, which we all know so well as the gas that bubbles up out of soda water.

In both these cases we told of a chemical *reaction.* In the first case, two simple substances joined together to make a new one. In the second case a complex substance broke apart into two simpler ones. In both cases the reaction happened because we applied heat; but this is not always necessary.

Courtesy, Bethlehem Steel Company
The molten pig iron shown above is the result of reduction.

Any piece of ordinary iron or steel left around outside, especially where it is wet or damp, will soon become covered with a yellowish brown powder. In everyday life we call this "rusting"; the chemist calls it oxidation. It is a synthesis of a compound, iron rust, from simpler materials, the metal iron and the gas oxygen.

When you eat an egg with a silver spoon and do not immediately wash the spoon, it will turn black, because the silver will react with the sulfur from the egg. When we burn coal in our fireplace or furnace, we perform another synthesis, because the carbon which is coal unites with the oxygen from the air to form carbon dioxide. But when we burn our dry leaves in the fall, or a log of wood, or gasoline in our automobile, or gas in our kitchen range, what happens is not so simple. Oil, gasoline, and especially wood or leaves, are very complex substances; but they all contain carbon, and in their burning this carbon forms carbon dioxide with the oxygen from the air, and the hydrogen in oil or gas similarly joins with oxygen and forms water.

Again, everything which we ordinarily call "burning" is "oxidation" to the chemist. But not all oxidation is burning. The rusting of iron, the so-called "drying" of oil paints, the turning rancid of butter—all these processes are oxidation and take place naturally in air; but the oxidation goes on so slowly that the materials do not get very hot, so we do not call it burning.

The opposite of oxidation, the process where oxygen is taken away, we call reduction. This also is a very important chemical process. Every year tens of millions of tons of iron ore from Minnestoa and Michigan are shipped down the Great Lakes to the steel plants in Pennsylvania, Ohio and Indiana. There the iron ore—which is really nothing more than a kind of "rust" which was formed out of iron and oxygen when the earth was still very hot—is mixed with coal in a blast furnace, and when this mixture is heated to the right temperature, then the carbon in the coal takes the oxygen away from the iron in the ore. The chemist says the ore is reduced to metallic iron which flows out in a molten stream. Many of the other metals which industry now uses in such a great variety are produced in the same, or a very similar, manner. Most metals are rarely found in the pure state in nature.

All of what we have described happened when the several substances with which we were experimenting were brought directly together. However, there can be reactions when the substances are not brought together directly. When the chemist does his experiments in his laboratory, or when a factory makes soap or dye or rayon, or when our bodies digest food we have eaten, then very often the chemical reactions take place in solution. When in summer you make a lemon drink for yourself you do not simply squeeze a lemon and pour the lemon juice into a glass of water: it is sour to the taste, so you add a spoonful of sugar and stir hard. After a little while the sugar disappears completely—it has *dissolved* in the water. Be careful not to say that the sugar has melted, for dissolving and melting are two very different things. You can melt butter very easily in a saucepan by heating it, and you get a liquid which is still all butter. But a solution of sugar in water is a mixture of the two, though a very different kind of mixture from the one of iron and sulfur we talked of before. Under a good magnifying glass, and certainly under a microscope, you could easily tell the particles of iron and those of sulfur apart; but no microscope in the world could show you the particles of sugar in a sugar solution. All drops of such a sugar solution are exactly the same. A solution is what the scientists call a homogeneous mixture.

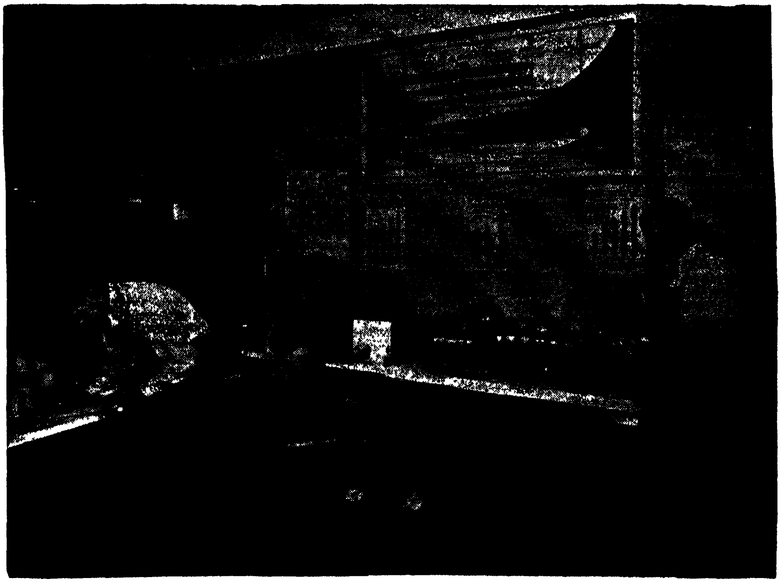
Now a great many substances that dissolve in water, and many that do not, will dissolve in alcohol or gasoline. Grease, for instance. You can take out grease spots with a little gasoline; "dry cleaning" is done in this way. Of course not all materials that dissolve in water dissolve in the same amount: if you have a pint of water you can dissolve nearly six times as much sugar in it as you can ordinary salt. Also, the amount you can dissolve usually increases when the liquid is heated, but this varies too. Hot water will take up a lot more sugar than cold water, but very little more salt.

When a liquid has taken up as much as it can of the substance to be dissolved we say that the solution is saturated. Now since hot water can take up more sugar than cold water, what happens if we make a saturated solution of sugar in hot water, and cool it off? It becomes more than saturated, so some of the sugar has to come out of the solution again: it crystallizes out. You can see this perhaps most easily when you make an eyewash—a solution of boric-acid crystals. Take some hot water, put a teaspoonful of boric-acid powder in it and stir hard until you can get no more to dissolve. Now pour the clear, saturated solution into another glass, and just wait: after a while, as the solution cools, beautiful crystals of boric acid will drop to the bottom.

There are several different types of reactions we can let happen with solutions. First we could take a solution of sulfuric acid in water and put a little piece of iron or zinc in it; immediately little gas bubbles form on the surface of the metal and the solution begins to fizz. The metal replaces the hydrogen that is in the sulfuric acid, and the hydrogen gas which is almost insoluble in the water bubbles out: if you hold a match above the solution the hydrogen gas will burn and form water. What takes place *in* the solution we call a displacement of hydrogen by zinc, or iron. But when we light the hydrogen *above* the solution we synthesize water out of hydrogen and oxygen. There are some other examples of synthesizing. Take a solution of copper sulfate, a deep blue chemical often mixed with other substances for use against insect pests, and put a steel wire in it. Leave it in for some time, and you will find the steel wire coated with a thin reddish brown layer of copper. Some of the iron has displaced the copper. That is, some of the iron has gone into the solution, while pure copper has been deposited along the wire.

Take a small piece of sodium—a beautiful, silvery, very light metal, and so soft that you can cut it with a knife, but also so active with air and water that it is usually kept under kerosene—and throw it on water. Immediately it begins to react and so violently that it melts and the little ball of shiny, silvery molten sodium metal darts here and there on the surface of the water with a loud hissing noise; it displaces the hydrogen in the water in the same way that zinc did in sulfuric acid, and when the reaction has ended the water feels a little sticky because now it has lye or caustic soda in it.

A still different, and perhaps the commonest way, of letting chemicals react with each other is to mix two different solutions. We might take a solution of silver nitrate and another of common table salt, which the chemist calls sodium chloride. Both of these are crystal-clear, colorless liquids, but the moment we mix them the whole mixture



Courtesy, American Agricultural Chemical Co.

A laboratory where soil is chemically analyzed to see what elements it contains.

From Frederic Lewis

Smoke, a product of imperfect oxidation.

becomes cloudy, and very soon thick, heavy, cheese-like globules drop to the bottom. The chemist calls this precipitation. What happens is that the two dissolved substances change partners: the sodium chloride and silver nitrate become sodium nitrate and silver chloride. But silver chloride is insoluble in water and precipitates out.

Let us take some calcium chloride—a white material which is sometimes hung up in a little sac to keep the basement dry in summer. Dissolve it in water. Then pour into that a solution of washing soda. Again we immediately get a thick cloud of precipitation, a white material which is the same as limestone. What we have left is a solution of sodium chloride, or common salt. We do not always get precipitation when we mix things. If, for instance, we mix a solution of soda and vinegar, or better yet, soda and dilute sulfuric acid, the solution begins to fizz, for one of the products of the reaction is carbon dioxide, a gas which bubbles out.

Sometimes we get just the reverse of precipitation: if we pour strong vinegar on crushed marble or limestone, which is insoluble in water, there will be an exchange of partners: and the calcium from the limestone will go into solution, and again carbon dioxide gas will fizz out.

Whenever we have such a reaction where there is an exchange of partners, the chemist speaks of double decomposition. These are very important reactions and they help us a great deal in making materials pure. If we dissolve in an acid a small piece of silver from Mexican or Indian jewelry, which is often made of coin silver, the solution will contain both silver and copper; but when we pour a solution of salt into it only the silver will precipitate out and the copper will stay in solution. In this way we can not only separate the silver from the copper but can also use the method for examining all kinds of materials to see if they contain silver. This type of examination the chemist calls analysis.

Sometimes, when a certain material is not soluble in a liquid, we can yet manage to divide it so finely into very tiny particles that these will mix uniformly with the liquid. We have almost a solution, but not quite. Substances that will do this are called colloids, from the Greek word for glue, because glue behaves that way; and these almost-solutions are called colloidal suspensions, or they are called emulsions if the mixture is of two different liquids such as oil and water. A hair shampoo and a salad dressing are good examples of an emulsion. Milk is a colloidal suspension of insoluble butterfat in water. Butter itself is the other way round—it contains innumerable little globules of water suspended in fat. Foam is very similar; it contains small gas bubbles in liquid. Mist or fog is the reverse, for here little drops of water are suspended in air, a gas. Smoke is a colloidal suspension of very small particles of soot in air. We can even divide gold into such small pieces that it will form a colloidal suspension in water.

HOW WE CAN TELL A COLLOIDAL SUSPENSION AND A TRUE SOLUTION APART

Usually it is quite easy to tell a colloidal suspension and a true solution apart, for a solution looks perfectly clear, and the colloid looks "milky," or cloudy. But sometimes such a suspension may look perfectly clear to the eye, and we can yet prove it is not a true solution by passing a ray of light through it. In the same way that one can follow the path of a ray of light through a smoke-filled or through a dust-filled room by looking at it from the side, so a ray of light is visible when it passes through a colloidal suspension; the light is reflected by the numerous very small particles.

Colloids have become very important, and a whole branch of chemistry has sprung up which deals with these substances. They find application in many industries, in tanning and dyeing, in the dairy industry, in making paints, soaps and rubber, and even in bread-making.

Another important factor in chemistry is the work done by the catalysts. These are substances which do not take part in chemical reactions; yet if they are present they speed up the reactions enormously. Quite often they consist of very finely divided metals, platinum, nickel or others like them. Nothing happens to the catalyst. It is not changed or affected at all, but simply by sitting on the side lines it manages to make things happen in a few minutes which otherwise might take days.

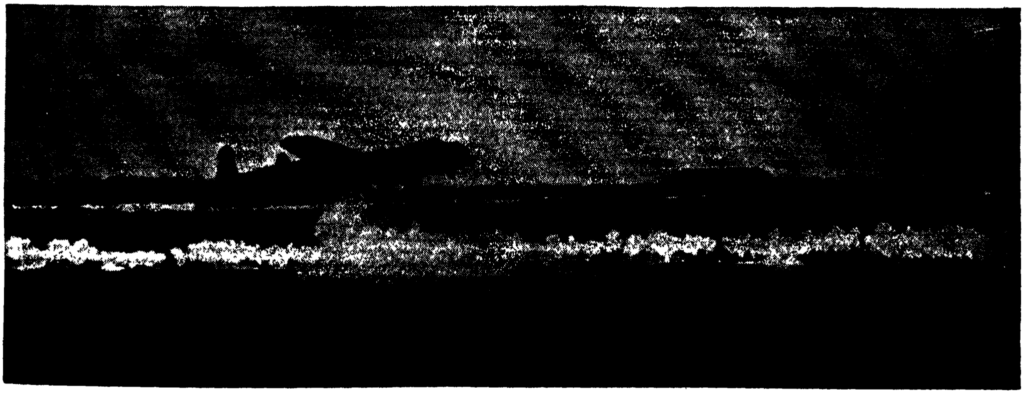
ONE OF THE MOST IMPORTANT BRANCHES OF CHEMISTRY—THE CHEMISTRY OF LIFE

Perhaps the most important part of all branches of chemistry is the chemistry of life. What happens when we breathe oxygen into our lungs, when food is digested in our stomachs and intestines, what happens in the liver and the kidneys, and what happens when the blood stream takes the digested food around to the various organs and tissues in our body that are tired and need food—all this is nothing else but chemistry. Because this type of chemistry is so extremely important to us as human beings, it is considered as a separate branch of science with a name of its own—biochemistry (biological or physiological chemistry).

The chemistry of plant life, too, is important. Perhaps it is even more important than that of animals, because animals and human beings are dependent upon plants; they could not exist without them, for it is the plants that grow the food for animals to eat. But plants can, and do, live by themselves. The marvelous thing about the way plants live is that they can use such very simple substances as water vapor and carbon dioxide —from the ground and air—to obtain the much more complicated substances that we call sugars and starches. This, again, is a synthesis, and because it takes place especially well when there is lots of light—sunlight of course—we call it photosynthesis, from the Greek word for light. We might well say that photosynethesis is the most important chemical process in all of nature.

All this time we have been telling you something about *what* happens in chemistry. Now the time has come to ask *why* it happens. To answer that question we must first go back to some articles that you have read on atoms and molecules. Let us review very briefly what you read there: you will remember that all matter is built up from three fundamental particles—the proton, which has a positive electric charge, the neutron, which weighs the same as the proton but has no charge at all, and the electron, which is about 1,850 times lighter in weight than the other two and carries a negative electric charge. When we put numbers of these particles together we build atoms.

Each atom has a nucleus where the protons and neutrons are packed together closely. Numbers of electrons whizz around this nucleus at terrific speeds. The remarkable thing is that there are always just as many electrons outside the nucleus as there are protons inside. Therefore, all the electric charges balance each other very neatly. Secondly, those electrons outside do not just run around helter-skelter, but are arranged in layers or shells. The innermost layer can have 2 electrons, but no more, the next one can have up to 8 but no more, the third one up to 18, but never more, the fourth up to 32, and so on. Also, it is not necessary for an atom to fill each layer before it starts building up the next one; some atoms have electrons whizzing around in a fifth and sixth layer, while the fourth has only 18



British Official Photo

Fog consists of little drops of water suspended in air, a gas. Above we see "Operation Fido," a British fog-lifting invention. This consists of a continuous line of burners set up on each side of a runway for planes.

instead of the 32 you might expect to find.

To the physicist the details of how many of each of these particles there are, and where they are, is of great interest. But the chemist is concerned mainly with two things—the *total* number of electrons (which is equal to the number of protons, and therefore also to the total electric charge of the nucleus) and the number of electrons in the outer two shells. How many neutrons there are in the atom does not worry the chemist. One might almost say that chemistry is the study of the behavior of the electrons in the outer two shells of atoms.

Courtesy, Du Pont Co.
Testing dyes manufactured in a chemical plant.

When the outermost layer of an atom has 8 electrons in it—and it does not seem to matter if any of the layers underneath are complete or not—then the atom has no desire for the company of other atoms, and it seems to be perfectly happy alone. Such are the atoms of the so-called "noble gases," neon, argon, krypton, xenon and radon. There literally is no chemistry of these gases. They do not react with any other substances. But when there are fewer than 8 electrons in that outer shell, or when there are 1 or more electrons outside a shell with 8 in it, then things begin to happen.

CHLORINE AND SODIUM HAVE A VERY STRONG AFFINITY FOR EACH OTHER

An atom such as chlorine, for instance, which has shells with 2, 8 and 7 electrons, is always ready to "borrow" an extra electron to turn that 7 into an 8. An atom of sodium, on the other hand, with 2, 8 and 1 electrons, is always willing and eager to "lend" that lone, outermost electron. No wonder, then, that, as the chemist says, sodium and chlorine have a very strong affinity for each other. They join up eagerly, and the compound they form is very stable: it is plain common salt.

Potassium has 2, 8, 8 and 1 electrons; rubidium has 2, 8, 18, 8 and 1. Cesium has 2, 8, 18, 18, 8 and 1 electrons; so they can all be expected to behave in much the same way as sodium, and they do: all of them are very ready to join with one atom of chlorine. We call these four the alkali metals. They are all light, soft, silvery metals; and in most of their chemical properties they are very much alike.

Chlorine, too, has its sisters; bromine, with 2, 8, 18 and 7 electrons; and iodine, with 2, 8, 18, 18 and 7 electrons. These three behave very much the same way. The main difference is that as they get heavier, they become more sluggish. Chlorine, with a weight of 35, is a yellow-green, poisonous gas that is very active indeed. Bromine is a heavy, brown, fuming liquid, somewhat less active than chlorine; and iodine comes in dark-violent, strongly smelling crystals, not anywhere near so active as chlorine. But all of them unite with one atom of sodium or of the other alkali metals, and because the compound of sodium and chlorine is ordinary salt, we call these three elements the halogens, or salt-formers, from the Greek words for salt and to create.

Now the metal magnesium has 2, 8 and 2 electrons; calcium has 2, 8, 8 and 2, so when they unite with chlorine, which is only 1 electron short of the ideal 8, they are not happy with just 1 chlorine atom; they need 2 before they are satisfied. Three further atoms, strontium, with 2, 8, 18, 8 and 2; barium, with 2, 8, 18, 18, 8 and 2; and the famous radium with 2, 8, 18, 32, 18, 8 and 2 electrons, all have the same arrangement of electrons in the outer two layers, so again they are very similar chemically. We call them the alkaline-earth metals.

But near chlorine we find sulfur, with 2, 8 and 6 electrons, or 2 short of the full quota of 8; so if sulfur unites with sodium it needs 2 sodium atoms to satisfy it, but with calcium or magniesium it needs only 1. And so we can go on. Aluminum has 2, 8 and 3 electrons, so it can handle 3 chlorine atoms before it has enough; silicon, with 2, 8 and 4, needs 4 chlorines; and phosphorus, with 2, 8 and 5 electrons, can handle up to 5 chlorine atoms.

THE NINE ATOMS THAT COME BEFORE NEON ARE THE LIGHTEST AMONG THE ATOMS

Up to now we have purposely not mentioned the lightest among the atoms, the nine that come before neon. None of these has any shell with 8 electrons in it. Hydrogen has altogether only 1 electron. Lithium has 2, then 1. So an atom of each of these two elements readily unites with 1 chlorine atom (which, you remember, has 7 electrons in its outer shell). Yet, because they lack the inner shell of 8, they do behave just a little differently from sodium and the other alkali metals. Lithium, it is true, is a metal, very light indeed; but hydrogen is a gas.

Fluorine, which has an inner shell of 2 and an outer shell of 7 electrons, behaves in nearly the same way as chlorine, but again not quite.

All of this sounds very complicated, especially if we would have to remember all these shells of electrons each time. However, chemists really came to know all about the chemical behavior of the various atoms long before any scientist had ever heard about electrons. And so, in chemistry, we still find it useful to go back to this older picture and to think of the atoms as having a number of "hooks," with which they attach themselves to each other. The chemist calls these hooks valences, and we say that hydrogen, sodium chlorine, etc., are *uni*valent; they have only 1 hook. Magnesium oxygen and calcium and others are *di*valent; they have 2 hooks. Aluminum has 3 hooks, and is *tri*valent; carbon has 4 hooks and is *quadri*valent.

When sodium lends its outermost electron to chlorine, it has only 10 electrons left, 2 plus 8. But that does not make it into neon, because neon has only 10 protons in the nucleus, and sodium has 11. So the sodium atom minus 1 electron is no longer electrically balanced. It has a positive electric charge. We call it a positive ion. Similarly, chlorine with its additional borrowed electron has an excess negative charge, and becomes a negative ion.

IRON AND OTHER ATOMS THAT BEHAVE DIFFERENTLY AT DIFFERENT TIMES

When atoms become heavier and more complicated, they often behave differently at different times, and with different elements. Iron, for instance, is sometimes divalent—has 2 hooks—and sometimes trivalent—has 3 hooks.

There is a whole series of atoms, fourteen of them, known as the rare-earth metals. All of these have 2, 8 and 18 electrons in the first three shells. But in the next shell they differ; they have anywhere from 18 to 32 in this fourth layer.

In the fifth and sixth shells again they are all the same, and have 9 and 2 electrons. Chemically, therefore, they behave almost exactly alike. Also, because they have 2 electrons in the outermost shell, and 9 (or 8 plus 1) in the one just inside, they behave as if they had 3 electrons on the outside, and had 3 hooks: they are trivalent. Uranium has 2, 8, 18, 32, 18, 12 and 2 electrons; and because 12 is 4 more than 8, uranium behaves nearly as if it has 6 electrons loose on the outside, or 6 hooks, and it has 6 valences. It is hexavalent.

There are elements, such as sulfur, which behave as divalent when they unite with metals—1 sulfur atom to 2 sodium atoms, or 1 sulfur to 1 calcium—but they behave as quadrivalent or hexavalent when uniting with oxygen. One sulfur atom can take care of either 2 or 3 oxygen atoms, and oxygen is divalent.

By Willem J. Luyten.

THE NEXT STORY OF SCIENCE IS ON PAGE 5423.

CHEMICAL TERMS USED IN THIS ARTICLE

Analysis—finding out what materials make up a substance.

Burning—a non-scientific term indicating the violent combination of a substance with oxygen. It is rapid oxidation.

Catalyst—a substance that changes the speed of a chemical reaction, without being permanently altered itself.

Colloid—a substance divided into very fine particles, and usually suspended uniformly in a mixture. For example, the butterfat in milk is a colloid suspended in water; it is an "almost-solution," a colloidal suspension.

Compound—a chemical union of two or more elements, producing a substance with properties of its own. The substance can not be broken down into its atoms by physical means.

Displacement—a chemical change in which an element frees another element (in whole or in part) from a compound, and itself unites with what is left.

Dissolving—the act of bringing a solid into solution. See Solution.

Divalent—having a valence of 2; a divalent atom has 2 "hooks" with which to attach itself to other atoms.

Double decomposition—a chemical reaction wherein the two partaking compounds exchange partners. For example, sodium chloride and silver nitrate react to form silver chloride and sodium nitrate.

Emulsion—a mixture of two liquids wherein finely divided particles of one are suspended in the other; a colloidal suspension of one liquid in another liquid. For example, oil in water.

Hexavalent—having a valence of 6; a hexavalent atom has 6 "hooks" with which to attach itself to other atoms.

Melting—the changing of a solid into a liquid by applying heat.

Mixture—a purely mechanical joining of two or more substances, where each retains its own properties; they may be separated by purely physical means. For example, a joining of sulfur powder and iron filings.

Negative ion—an atom which has gained an electron and, as a result, possesses a negative electric charge.

Oxidation—the combination of a substance with oxygen, accompanied by a production of heat.

Photosynthesis—the process in a plant whereby carbon dioxide and water are combined—through the action of sunlight—to form starch.

Positive ion—an atom which has lost an electron and, as a result, possesses a positive electric charge.

Precipitation—the process wherein a substance separates from a solution because it will not dissolve in that solution; it falls out (or precipitates) because it is insoluble in that liquid.

Quadrivalent—having a valence of 4; a quadrivalent atom has 4 "hooks" with which to attach itself to other atoms.

Rare-earth metals—a series of fourteen metallic elements (atomic numbers 58 through 71) closely similar in physical and chemical properties. The name comes from the fact that originally the oxides of these metals resembled what were known in that time as earths (lime, magnesia, etc.).

Reaction—a chemical change.

Reduction—the process whereby oxygen is removed from a substance; the opposite of oxidation.

Saturation—the state of a liquid when it has taken up all it can of a substance to be dissolved.

Solution—a combination of substances, one of which is usually a liquid, in which all the parts are uniformly mixed together and never separate out. For example, a salt and water solution. The proportions of the various parts can be changed within certain limits.

Suspension—a finely divided substance floating in a liquid; the particles settle very slowly. For example, dirt in water.

Synthesis—a chemical union of two or more substances, producing a new material that possesses properties entirely different from each of the ingredients.

Trivalent—having a valence of 3; a trivalent atom has 3 "hooks" with which to attach itself to other atoms.

Univalent—having a valence of 1; a univalent atom has 1 "hook" with which to attach itself to another atom.

Valence—the number of electrons an atom can gain, lose, or share (in pairs) with another atom; the number of "hooks" an atom has. Atoms of some elements have more than one valence.

SIR PHILIP SIDNEY

THE FLOWER OF THE ELIZABETHANS

PEOPLE on the streets rushed to catch a glimpse of him as he strolled by. The noble lords and ladies of the court loved his gentle manners and admired his handsome appearance. The scholars respected his wisdom, his wit and his learning. To soldiers he was the ideal soldier. His name was Sir Philip Sidney. Many people today believe that William Shakespeare had Sir Philip in mind when he described Hamlet in these terms:

> "The courtier's, scholar's, soldier's eye,
> tongue and sword;
> The expectancy and rose of the fair state;
> The glass of fashion and the mould of form,
> The observed of all observers."

For Sir Philip Sidney was a man of fashion, a noble courtier, a brilliant scholar and a brave fighter; he was as much at home in the country as in the town; he was a favorite of the Queen and beloved by the humblest of her subjects.

He has been called the Flower of the Elizabethans. In him the English Renaissance brightly showed its many-sided fire and genius. He was born plain Philip Sidney in Kent, in 1554. He studied at both Oxford and Cambridge, and when only eighteen he made a tour of the Continent, visiting France, Italy, Hungary, Germany and Flanders. Some say Queen Elizabeth sent him on this journey, hoping that he could form a league of nations against Spain. If so, he failed, as you might expect. A lad of eighteen, be he ever so bright and winning, still has a good deal to learn about how to carry on that difficult trade, secret diplomacy!

Sir Philip Sidney, one of the brightest ornaments of England's Golden Age. Scholar, courtier, soldier and man of fashion, he won the admiration of Queen and country.

We learn that when he was twenty-six he quarreled with one of the nobles of the court, and there was talk of a duel—talk that came to the Queen's ears. She forbade the duel, and Sidney retired to the country. Three years later, however, he was back at court; and Elizabeth was conferring knighthood upon him.

At this time the throne of Poland was vacant, and his name was proposed as the new king. But Elizabeth could not bear to lose him from her court, and so she prevented the election. Later he did cross the water to become governor of Flushing, in the Low Countries, as we shall tell you.

Throughout his very active life Sir Philip devoted many hours to writing and study. Among his friends was Edmund Spenser, author of The Faerie Queene. With several other poets Sidney and Spenser founded a literary society whose influence on English literature lasted for many years. Certain critics of the day had talked against the drama and poetry written by English men of letters. Enraged by their stupid attacks, Sir Philip Sidney wrote a brilliant essay defending English literature. This essay, The Defense of Poesy, is regarded today as the first example in English of a truly fine critical work. He wrote many sonnets in memory of the love he had once felt for a certain noblewoman. These rank among the finest examples of English poetry in the Elizabethan period.

Sir Philip's romantic work, Arcadia, was very popular during his lifetime. It was not printed in book form. His friends borrowed the manuscript, read the pages and then passed them on to others. Spenser was so impressed by it that he used some of the material of the Arcadia in The Faerie Queene. Shakespeare also realized the beauty of this work and rewrote parts of it into King Lear. Sir Philip's wish, that his writing would inspire other men to greater achievements, was, indeed, fulfilled.

Scholars of our time can appreciate the true genius shown in Sir Philip Sidney's compositions. Yet his valiant deeds are as worthy of praise. We recognize in today's accounts of brave men who are injured and die on the battlefields of the world the spirit of true courage and self-sacrifice. The people who lived in the days of Queen Elizabeth recognized that same spirit when they heard the account of Sir Philip's death, at Arnhem, in Holland.

In 1586, Spain attacked the Netherlands. The Spanish king thought that he could crush the Dutch and weaken their English allies by this move. At this time Sir Philip Sidney was serving in Holland as the governor of Flushing. When Queen Elizabeth sent an army to assist the Dutch, Sidney's small force joined with the larger group.

As he rested in his tent, a messenger dashed in with startling news. He had seen a land convoy loaded with provisions for the Spanish armies. The destruction of that convoy would prevent the Spaniards from receiving their supplies. Sir Philip knew that this would aid his own forces. With a small British detachment he set out to attack the convoy. Beside Sir Philip rode a general of great fame. When Sidney saw that this veteran wore no armor on his legs, he unclasped the greaves about his own legs and tossed them away.

A fog covered the countryside, and the English could not see very far into the distance. When the fog cleared, they discovered that they had walked into a trap. A whole army faced them. Deadly Spanish guns and musket fire swept their ranks. A fierce battle raged for an hour and a half.

In the midst of the fighting rode Sir Philip, encouraging his men by his own boldness. One horse was shot from under him, and he quickly mounted another. Suddenly, the soldiers saw him clutch his unprotected thigh. Blood flowed through his fingers from a deep wound. He would have continued to fight on, but the horse, frightened by the din of battle, galloped off the field.

Weakened by the loss of blood, Sir Philip rode back into camp. He called for a flask of water to ease his parched throat. As he put the flask to his lips, a dying soldier was carried past him. The man's sunken eyes stared at the flask, and he licked his dusty lips. Taking the flask from his own lips, Sir Philip handed it to the dying soldier with these unselfish words, "Take it! Thy necessity is yet greater than mine."

Yet he, too, was dying. When word of his passing reached England, the whole country mourned for this gallant nobleman who had met his death with the chivalry and high honor that had distinguished him while he lived.

THE NEXT STORY OF GOLDEN DEEDS IS ON PAGE 5735.

Sir Philip Sidney's heroic death on the battlefield. Though parched with thirst, he unselfishly gave his flask of water to a dying soldier.

Royal Geographic Society

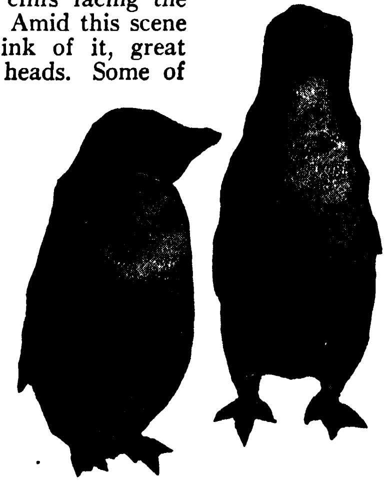
Shackleton's ship. The men tied ropes to snow mounds to guide them back when they walked far from the ship.

THE SOUTH POLE MEN

ANTARCTICA, as we call the continent in the region of the South Pole, lies entirely under ice. The site of the South Pole is from a thousand to two thousand feet deep beneath this frigid mail. And of the 14,000 miles of continental coast only 4,000 miles are free from ice, which in places forms enormous unbroken cliffs facing the sea, hundreds of feet high. Amid this scene of eternal cold, as we think of it, great mountains throw up their heads. Some of them, such as Erebus and Terror, are active volcanoes, living furnaces covered with ice and snow.

Antarctica is a land mass as big as Europe and Australia put together. Though a considerable portion of it is yet untrod by man, several seams of coal have been found on the mainland, proving the existence of luxurious forests and blazing sunshine in ages long ago.

We may some day draw coal for heat from this region of frost and blizzard. In fact, the reason which urged the commerical pioneers into the seas that wash these shores was the need for heat and light. We had no gas then; oil was the source of light, and seals and whales were the source of oil. So it was Southward ho! that men went, on voyages of hardship, sickness and peril.



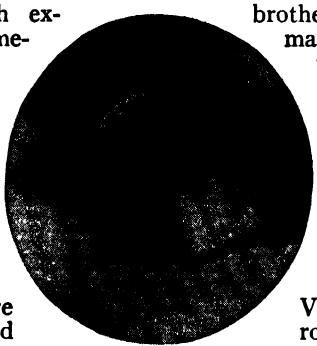
Herbert Ponting

Penguins, quaint dwellers in Antarctica.

The search for the South Pole is not traced into the dim distant centuries. Indeed, when in 1487 Bartholomew Diaz sailed round the Cape of Good Hope, and when Drake, almost a hundred years later, sailed round Cape Horn, hardly anyone in the world gave a thought to the lands farther south. Before that geographers had believed that Tierra del Fuego (the Land of Fire), south of the Strait of Magellan was connected directly with the New Guinea coast. But Drake's voyage made men think that there must be a great southland or third world somewhere in the unknown regions of the South Pole which they called the Antipodes. Nobody did much about this vast unexplored region, however, in the next two centuries.

French, Dutch and English explorers did try to find out something definite about the far-off regions, but it was not until 1773 that the Antarctic Circle was crossed. Captain James Cook, sent out by the British Admiralty, was the man who crossed the line and became famous. Following in Cook's tracks, Fabian von Bellingshausen was sent out by Alexander I of Russia to explore the Antarctic seas. He, too, crossed the circle. But it was the whalers and sealers who pieced together more and more knowledge of the far south. They discovered South Georgia, the South Shetlands and other islands, all of which were believed at the time to be actual mainland.

Many of these hunters were fine spirits, touched by a sense of the romance and mystery of their calling. They added genuine exploration to the hard and hazardous chase of oil-charged sea animals. Such men were John Biscoe and James Weddell, typical whaling captains, who, in turn, reached the Antarctic in their tough little cockleshell ships.



An inquisitive hairseal pokes its head above the ice.

Then there were men like the Enderby brothers, whose name lives on the map. These men always hoped that if the voyages of exploration they promoted were commercially unprofitable, some new island, some archipelago, even the legendary continent itself, might turn up to justify the risk. It was the old merchant-adventurer spirit of Elizabethan days surviving into the nineteenth century.

Von Bellingshausen, who sailed round the world in 1803, led a Russian expedition to the Antarctic. From 1819 to 1821 he reached 70° South Latitude, where he discovered and named Peter I Island and Alexander I Land. Well acquainted with Cook's work, he added to it, and confirmed the impression that south of latitude 60 there was continuous open sea surrounding the ice-pack which girdles the frozen continent.

Weddell reached beyond 74° South Latitude and discovered the great bay which

Pictures, Herbert Ponting, from THE GREAT WHITE SOUTH

Majestic icebergs, and pompous, conversational penguins—these are familiar sights to the Antarctic explorer.

now bears his name. Biscoe named Enderby Land and found Graham Land, Adelaide Island and Biscoe Islands. John Balleny, another captain sent out by the Enderby brothers, reached what we now call the Balleny Islands. Then came the French naval officer D'Urville, with a three years' voyage; and close on his heels followed the American Wilkes, and Ross. D'Urville's name is commemorated in that of the D'Urville Sea; and it is to him, by the way, that the world owes the discovery and preservation of the famous statue of the Venus of Milo, which he found in the Island of Melos in 1820. D'Urville also gave names to Joinville Island and Louis Philippe Land.

The three expeditions, French, American and English, were in progress at the same time, crossing each other's tracks. Charles Wilkes (1798-1877) surveyed, as far as possible, the coast of Wilkes Land, which has a northern limit beyond the Antarctic Circle. It also embraces Adélie Land, which D'Urville had already reached and named.

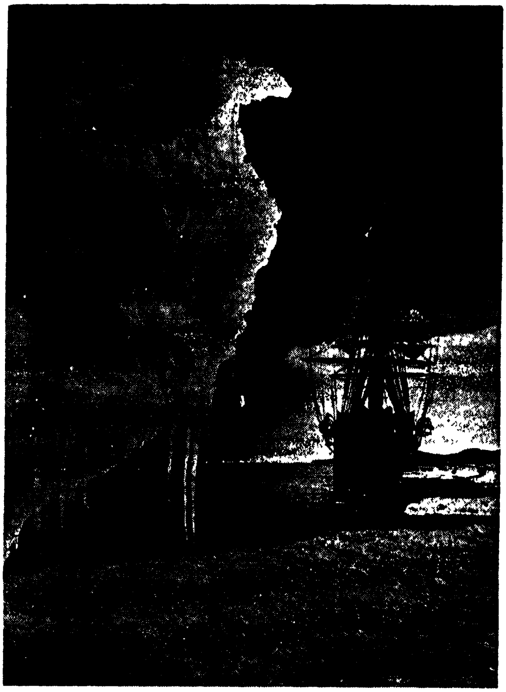
Wilkes was unfortunate in his ships and in his relations with his officers and crew, who alleged that he was inhumane. He was brought to court-martial on these charges and was justly acquitted.

A great figure of his time was Sir James Clark Ross, (1800-62) whom we have already met in the far north discovering the North Magnetic Pole. The British Admiralty sent him in 1839 to discover the South Magnetic Pole. In the course of the greatest cruise then accomplished, in and through the ice, he enormously advanced our knowledge.

SIR JAMES CLARK ROSS SAILED STRAIGHT FOR THE SOUTH MAGNETIC POLE

With his two little ships, the Erebus and the Terror, he battled with floes and bergs, with unknown tides and desperate winds. He sailed straight for the South Magnetic Pole till land stopped him at what we now call Cape Adare, where he espied a mountain rearing its icy head ten thousand feet into the skies. This he named Mount Sabine, after a brilliant scientist of the day.

The Ross Sea marks another of his discoveries. Others were the Admiralty Range, Possession and Coulman Islands, and two flaming volcanoes, which he named, after his ships, Mount Erebus and Mount Terror. East of a cape which he named Crozier, after his second in command, Ross surveyed a great stretch of the ramparts of the land,' the famous Great Ice Barrier. He found and named South Victoria Land as well. Then, after thrilling adventures, he came back, the first man to take a ship beyond 75° South Latitude.



Herbert Ponting, from THE GREAT WHITE SOUTH
The Terra Nova (New Land), Captain Scott's ship.

The next ship in the Antarctic Circle was the steamship Challenger, under the command of Captain Nares in 1874, when the Great White Silence had been left unvisited for thirty years. After that a further twenty-one years passed before a second steamer appeared in the same region. But it was the frisky little sailing ships that first let light into the Antarctic mysteries.

The Erebus and Terror reached England, after a cruise of nearly four and a half years, little the worse for their battering by ice or by collision in the dark. They were claimed at once by another heroic spirit, Ross's old friend Sir John Franklin. It was the two little ships which had been farthest south that Sir John Franklin chose for the most tragic of all polar voyages. It was the voyage which ended in the loss of himself and all his men as they battled their way through the terrible Northwest Passage.

So far all the voyages into the Antarctic had been in the nature of seasonal visits. Explorers sailed south of the circle for a

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Wreck of the Endurance, Shackleton's ship. Shackleton and his men managed to escape with their lives.

short summer, then north to safety for the winter, and back again when light and warmth returned to the higher latitudes. But the custom was broken for the first time in 1897, when the Belgian expedition in the Belgica, under Adrien de Gerlache, sailed south. Lingering too long over scientific observations on the way down, these explorers, to their amazement, when in mid-ice within the circle, on May 15 lost the sun, not seeing it again until ten weeks had gone by.

The Antarctic winter had caught its first ship! The crew suffered extremely, though well fed. Vitality sank, spirits dropped to zero, men's minds wavered and tottered, and death boarded the little steamer when Lieutenant Danco passed away in the darkness. Light returned in July, but the ship remained frozen in until January, 1899. Summer in southern latitudes is our winter, you know.

The event was remarkable; so was the personnel of the ship, for her mate was Roald Amundsen, future discoverer of the Northwest Passage and of the South Pole.

In 1898 an English expedition, under Norwegian-born Carsten Egebarg Borchgrevink, sailed in the Southern Cross, and was the first to winter on the Antarctic mainland. Experiences varied little as to cold and desolation from those of the Arctic; but there was this difference—the utter absence of visible life in winter, except an occasional emperor penguin.

In summer there are penguins nesting near the shores, and there are seals, grampuses, and other whales in the water. In winter there is nothing in the far south to take the place of the Arctic bears, foxes, musk-oxen, reindeer and sea birds: and there is no human soul like the Eskimo.

Borchgrevink's adventure was a picturesque and gallant one, unattended by notable geographical results. He should be remembered for the fact that his was the first expedition to winter ashore. Nikolai Hanson, a Norwegian, the naturalist of the party, who had left a post at the British Natural History Museum to join the ship, died before summer returned, and was buried in one of the strangest graves in the world.

Before he died he named the site of his tomb: "It shall be where I was photographed last year, beside the boulder on the summit of Cape Adare—there, on the leeside of that stone."

And so it was. His friend, Louis Bernacchi, a Tasmanian scientist, began the digging of the grave, assisted by two Finns who were in charge of the dogs. In a full day's work they dug but four inches. Next day they blasted with dynamite. Eighteen inches down they came upon a buried glacier, which must have been there, unmelting, unaltered, unrevealed, for centuries.

HANSON'S STRANGE BURIAL IN A CONCEALED GLACIER

In that concealed glacier beneath the windswept boulder, wrapped in the Norwegian flag, Nikolai Hanson was buried. His grave was sixty-five inches deep in the hidden ice. Hanson was a descendant of the Vikings whose dead were the first white men buried in America, over a thousand years ago. Strange, thought his sorrowing comrades, that this later Viking should have come almost to the opposite extremity of the earth to find his sepulcher.

Eskimos witnessed the Viking burials in America. The two Finns witnessed this Antarctic burial. With grief in their hearts they raised native songs of mourning. Perhaps these songs were not unlike those which their Eskimo kindred sang in the far-off days of Viking discovery in the New World.

The Southern Cross party were the first to witness the arrival of the penguins. They met millions of them where they had marched inland over the ice, twelve miles from the sea. For fourteen days the procession of birds went on all the twenty-four hours of each undarkened day and night.

The Southern Cross steamed to the highest latitude yet attained. The leader and a comrade made a short sledge journey on land, reaching 78° 50′ South Latitude. With that record the nineteenth century closed.

ROBERT FALCON SCOTT, A HERO OF ANTARCTIC EXPLORATION

The twentieth century brought into prominence two figures destined to win immortal fame by their achievements and their heroism. They were Robert Falcon Scott (1868-1912) and Ernest Henry Shackleton (1874-1922).

Scott was of the great Devonshire line of seamen, born at Outlands, Devonport. He was a delicate boy whom it was difficult to rear beyond infancy; a boy who, as he told us in his last diary, "had to force himself into being strenuous, having always an inclination to be idle." Yet he was in the navy at thirteen. At thirty-three he had so fine a service record that he was appointed in 1901 to lead the Discovery expedition, taking with him Shackleton, Dr. E. A. Wilson and others who were to win undying fame.

Scott landed at the foot of Mount Terror on Ross Island. Then, turning his ship eastward along the Great Barrier, he discovered a new territory which he named King Edward VII Land. Ross had given the name of South Victoria to his great land discovery, meaning that the whole of the Antarctic continent should bear that title. Too many discoveries were being made for such a plan to be followed, however, and presumably Antarctica will forever remain its official name.

Scott wintered in McMurdo Sound, and in the spring, accompanied by Shackleton and that knightly spirit Wilson, set out on the first great sledge journey south. Over dreadfully rough and dangerous ice the party proceeded for 370 miles due south without being able to reach the mainland.

Scott had ever in sight the great mountain range which continues South Victoria Land to the south. But the loss, one by one, of nearly all the dogs; the exhaustion of food supplies; and the breakdown, through scurvy, of Shackleton, drove the party back. They returned after fifty-nine days of deadly peril and hardship, victorious in this, that Scott had discovered a way to the South Pole itself. In the following year he marched 300 miles west over Victoria Land, and was home again in England by 1904, with a great record of work achieved, but pining to be off again to the scene of his labors.

Shackleton was the next to venture forth, as commander of the Nimrod. He reached Cape Royds toward the close of the Antarctic summer in 1908. He was compelled to land there in a hurry, as he found the path to King Edward VII Land blocked by ice. There was also a danger of the coal supply's failing before his ship could get away for the winter.

The seemingly solid ice on which stores were landed suddenly broke up under the swell of the sea. This imperiled not only the stores but eight Mongolian ponies which Shackleton had taken for sledge work. A gale raging at a hundred miles an hour nearly wrecked the ship, and covered the shore with spray which instantly turned to ice.

Waves that broke over the ship immediately froze and became ice a foot thick. As some indication of the power of the gale it may be noted that a Russian boot weighing seven pounds was torn out of the crate in which it was lying and blown three-quarters of a mile.

However, such things are part of the everyday life of the Antarctic. There summer temperature is never above the freezing point. Men lose themselves and are blown away if they walk but a few feet in the darkness of the long winter night. And the wind is such that, in standing to cut ice with a pickax, a man can actually lean on the wind; and, indeed, must do so to maintain his position.

SHACKLETON'S FATAL ERROR— HE USED PONIES INSTEAD OF DOGS

Shackleton adopted Scott's route for the Pole, and would have gained it at the first dash but for one fatal error. He relied on ponies instead of dogs. The ponies, lacking the salt which they were accustomed to lick on their native steppes, ate the salt sand, and it killed four of them. So the pulling power of the party was insufficient and progress was too slow for the food supply.

Nevertheless, Shackleton and his party made a superb march over Beardmore Glacier, and on January 9, 1909, reached, on King Edward VII Plateau, a position 420 miles south of previous records. They were within ninety-seven miles of the Pole, but a furious gale raged for sixty hours and nearly killed them all. Food was short, vitality was ebbing so that bodily heat could not be maintained even under full pressure of man-hauling the sledges after the death of the last pony.

So the party turned back and reached the base just alive. In the meantime a second party from the expedition, Professor T. W. Edgeworth David, Dr. A. F. Mackay and Dr. Douglas Mawson, had made a terrific journey over glaciers and treacherous ice-fields. On January 16, 1909, in 72° 25′ South Latitude, 155° 16′ East Longitude, they had discovered the South Magnetic Pole.

That journey alone was a harsh epic of terror and triumph. The ice lay in folds which were really little hills, and was seamed with crevasses, some of them the more dangerous because covered with snow-lids. Into one of these Mawson suddenly plunged, suspended ten feet down by his sledge harness. In danger of death, he occupied the time while he was being rescued in picking off ice crystals of a new formation from the walls of his death trap. These he threw up to his comrades, in case he should not survive to examine them at his leisure.

Keystone

Sir Douglas Mawson, who located the South Magnetic Pole in 1909.

Douglas Mawson (1882–   ) was a Yorkshire boy. He went to Australia in his youth, became a brilliant scientist and carried out a geological survey of the New Hebrides at twenty-one. He was with Shackleton at twenty-six, and in 1911, when twenty-nine, led the Australian expedition to Adélie Land in the Aurora. His personal contribution to the knowledge of our subject was the discovery and exploration of what he called King George V Land. Let us follow him in a sledge journey of extraordinary difficulty.

In the summer of 1912 he set out with two dog-teams. His companions were Xavier Mertz, a dashing scholar-lawyer who was the champion ski-runner of his native Switzerland, and a towering young Englishman, Lieutenant Ninnis.

The little party progressed with difficulty over land covered with ice and snow, converted by hurricanes into hillocks, swells and ridges which looked as if a stormy sea had suddenly become rigid. Everywhere crevasses abounded, covered by snow, and descending hundreds, even thousands of feet.

On the thirty-fifth day out, when they had covered 315 agonizing miles, Ninnis suddenly disappeared down one of these crevasses. With him went the best dog-team, the sledge on which was nearly all the food for the men, all the food for the dogs, and nearly all the implements. Six emaciated, foodless dogs remained. A tent but no tent poles, a cooking stove and oil, but only a little pemmican and some thirty-five pounds of almonds and raisins were the remains of the equipment.

All that day Mawson and Mertz endeavored to reach their lost comrade. But except for a faint whimper from one of the dogs which they saw lying on a ledge below with its back broken, 150 feet down, and a blurred outline of the sledge, they could discover nothing. Their ropes were far too short to reach down the crevasse to where Lieutenant Ninnis must have fallen. There was no sound from him. Death must have come with merciful suddenness to the brave fellow as he fell headlong into his grave.

The survivors turned homeward in a desperate plight. An abandoned sledge which they had thought useless was found on the trail and broken up with spare skis to make poles for the tent. One by one the starving dogs died, and part of their flesh was given to the remainder, part was eaten by the men.

Finally the last dog died, and the two men dipped deeper into their sledge rations, such as they were. They boiled snow for water and soaked in it bags which had contained tea or cocoa. Then poor Mertz sickened and died. Mawson was alone in that horrible land, with a hundred miles to go, a few handfuls of raisins, and the carcass of a dog for food. The sledge with its tent, lamp and oil had to be dragged singlehanded, up ice-hills and down ice-hills. Again and again it pulled him with it, sometimes into crevasses, sometimes over them.

Once he dropped six feet into one of these yawning chasms, hung by his harness and spun. He managed to pull himself up, but on reaching the top, fell again, freezing,

The Bettmann Archive

Captain Roald Amundsen near the South Pole, "shooting the sun" with his sextant, to determine his position.

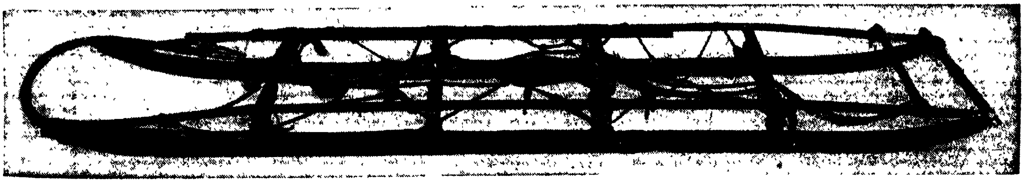
exhausted, nearly dying, burdened with snow and ice which had broken and fallen on him. Once more he hauled himself out, feet first this time, then lay trembling and faint, motionless for an hour on the crumbling brink of the awful ice-pit.

Somehow he managed to struggle on, and then, when he had only two pounds of food left, he came upon a depot of supplies left by men who had departed only six hours before his arrival. There was a frightful journey down over the ice plateau. With his smooth shoes, he was blown miles and miles out of his course by the wind. Finally he broke up his wooden instruments, left the nails projecting, and used these as grappling irons for his feet. At last he reached the base—to find that his ship had sailed, leaving five men and stores to sustain him during the approaching winter. Finally, in the spring of 1914, he returned to civilization after one of the most appalling experiences any man ever lived to tell.

In 1929 and again in 1931, Sir Douglas Mawson returned to the Antarctic and carried on further valuable exploration.

Before returning to Scott and his affairs, we must note the discovery by Professor Erich von Drygalski of Kaiser Wilhelm II Land. Dr. Otto Nordenskjöld wintered in King Oscar II Land. Dr. W. S. Bruce spent some months at Laurie Island and explored the coast of Coats Land. Excellent but less important work was done by Dr. Jean Charcot in the Palmer Archipelago, and later in Bellingshausen Sea.

It came to a race for the South Pole after all, and Captain Roald Amundsen won. He had set sail for the North Pole, but learning that Peary had already succeeded there, he secretly made his way across the world. Using the knowledge of



American Museum of Natural History, New York

Amundsen's sledge that reached the South Pole, December 14, 1911. Eighteen Eskimo dogs drew the sledge.

Keystone View Co.

Lincoln Ellsworth and Bernt Balchen on a test flight. Both later flew over Antarctica, though not together.

routes and conditions which Scott and Shackleton had published, he attacked the problem from the Bay of Whales on the edge of the Great Barrier. He wintered there, and on October 20, 1911, set out with dogs and men on a final dash for the Pole.

He had in the main fair going, though he had to march through blizzard spells which few but these Vikings would have been tempted to encounter.

There were deadly dangers, too, from crevasses. Perhaps the most sensational scene of all was when one of the party, Helmer Hanssen, fell with his sledge into a crevasse six feet wide, the sledge slanting across it, the dogs safe across. A movement or two would have sent the whole lot, man, sledge and dogs, spinning down. And that movement was threatened by the dogs, which fought as they always fight at the least provocation.

Like a lot of roaring tigers (says Amundsen) the whole team set on each other till the hair flew. If this went on all was irretrievably lost. One of us jumped the crevasse and fortunately got them to stop. At the same time Wisting threw a line to Hanssen and hauled him out of the crevasse.

Of the fifty-two dogs with which Amundsen started, he killed twenty-four when the worst of the hauling was over, and ate them. Eighteen reached the Pole, pulling marvelously up the frightful slopes. Twelve reached the home base once more.

When rather more than half the journey had been covered, the party had to climb a mountain range over 10,000 feet high, and up it they went with their terrific sledge-loads, man and dog working together. After this climb they dropped 3,000 feet, and next had to surmount another glacier high and perilous. Then they were on a plateau which for the next 120 miles sloped gradually downward to the Pole.

Roald Amundsen reached the South Pole on December 14, 1911, and the dream of ages was realized.

Meanwhile Captain Scott had sailed from London in the Terra Nova in June, 1910, two months before Amundsen had turned his ship about from the north to the south. Scott wintered on Ross Island again. During the spring depot-laying parties got far forward, but from the outset Scott met difficulties.

The weather was of exceptional severity;

the sea ice over which stores had to be carried broke up, and some ponies were lost in this way. Huge grampuses seized others.

Half his haulage power was lost at the base, and the weather continued bad. Scott delayed his start in order to spare hardship to the remaining ponies. Dogs would have got him through, all seasoned Antarctic men say; ponies doomed him. On the great march for the Pole, which was begun on January 4, 1912, the ponies were used up and had to be killed one by one before half the journey was accomplished. Then the Pole party had to do the hauling, up mountains, over glaciers, across ice and snow, by themselves.

Five men made the dash to the Pole, which was to lead them to their doom. They were Captain Scott, Dr. E. A. Wilson, Lieutenant H. R. Bowers, Captain L. E. G. Oates and Petty Officer Edgar Evans—as brave a band as ever faced the Antarctic. For thirteen months nothing was heard of them. Then the finding of the last camp and the men's diaries gave to the world the story of their incredible fortitude and nobility of mind. The tragedy was all the greater, as this fateful camp was pitched only eleven miles from a well-supplied depot.

Keystone View Co.
Sir George Hubert Wilkins, Polar explorer.

The party had reached the Pole on January 18, to find their triumph dashed by the knowledge that another had been before them. At this loneliest place on earth they found a tent and message written in Amundsen's hand: "Welcome to 90 degrees." A letter from the same hand told that Amundsen had reached the Pole a little over a month earlier.

Sad and heavy-hearted, the men turned back. Their equipment and their rations were insufficient. Though it was summer, the weather, which had favored Amundsen, turned against them. The mighty Edgar Evans, their mainstay in pulling the sledge over the rough ice, broke down and held them back. To make matters worse, he had a serious fall on Beardmore Glacier and died on February 17. Next the gallant Oates began to weaken. Despite the encouragement of his comrades, he knew that he was fatally retarding them. So one morning, when the blizzard was raging mercilessly, he said, "I'm just going outside, and I may be some time." On terribly frostbitten feet he tottered out into the bitter cold and storm, never to return, so that his friends might have a chance to live. "We knew that Oates was walking to his death," wrote Scott, "but though we tried to dissuade him, we knew that it was the act of a brave man."

Wilson and Bowers struggled on. Within a short march of the supply depot, One Ton Camp, which a relief party had left only a few days before, the elements drove them to their little tent. They had fuel for one hot meal and food for two days, but the blizzard raged for more than a week and held them there to die. They made up their diaries and wrote their farewell letters. Scott's spirit, especially, rose above all suffering, and in a noble message he set down the reasons for the failure and paid tribute to his comrades. Death came after four days, Scott evidently being the last alive.

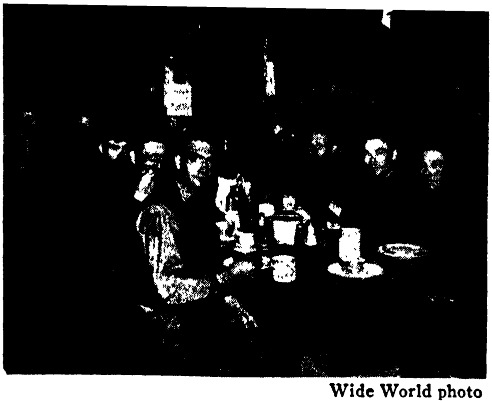
Not until November 12, 1912, did a search party under Dr. Atkinson find the silent tent, by instinct rather than by sight. The bodies of the three men were left there, embalmed in the ice. When Shackleton sought the site a few years later the tent of death had drifted away with the great ice sheet and could no longer be found.

In 1914 Sir Ernest Shackleton—he had been knighted in 1909—started on his second voyage to the Antarctic. He set himself the appalling task of actually crossing the Antarctic continent from the Weddell Sea to the Ross Sea—1,800 miles, of which half, from the Weddell Sea to the Pole, was unknown ground. Nearly 5,000 men volunteered to fill the 56 places available in the expedition, which left just after the first World War had broken out. The ship—Endurance was her name—and the entire company were offered to the government for service, but were bidden to proceed on their way. When they returned two years later, after incredible adventures, their first question was, "How did the war end?" The war was then but midway through its course.

In brief, this is what happened: New land

Wide World photo
Byrd's second expedition. A dog-sled team with supplies sets out from the ship, to make camp on Little America. Admiral Byrd's expeditions were carefully planned.

Byrd Expedition
A more modern way of transporting supplies from ship to camp—by tractor, with wheels on runners. The expedition of 1939 had a great snow cruiser.



Wide World photo
Members of the second Byrd expedition sit down for dinner, in Little America. The camp was provided with radio, which brightened lonely days and lessened the feeling of being cut off from the world.

was sighted and named Caird Coast, but the weather was bad, the Endurance could find no landing place and was frozen in, in January, 1915. For nine months she drifted with the ice until she was finally crushed to fragments, leaving the 28 men stranded on an ice-floe. Luckily they saved much food and gear, as well as three boats. For five months they camped on their icy raft, in imminent peril of their lives, ill-fed and equipped. In April, 1916, the floe broke up and they took to the boats, reaching Elephant Island with its glaciers after six days of terrible hardship. But the sufferings were not yet over. Leaving Frank Wild in charge of 21 men on a desolate sandy spit swept by blizzards, with only the barest food supply and two upturned boats for refuge, Shackleton with five men took to the remaining 22-foot boat and reached South Georgia, 750 miles away. After three attempts he succeeded in August, 1916, in rescuing the entire party.

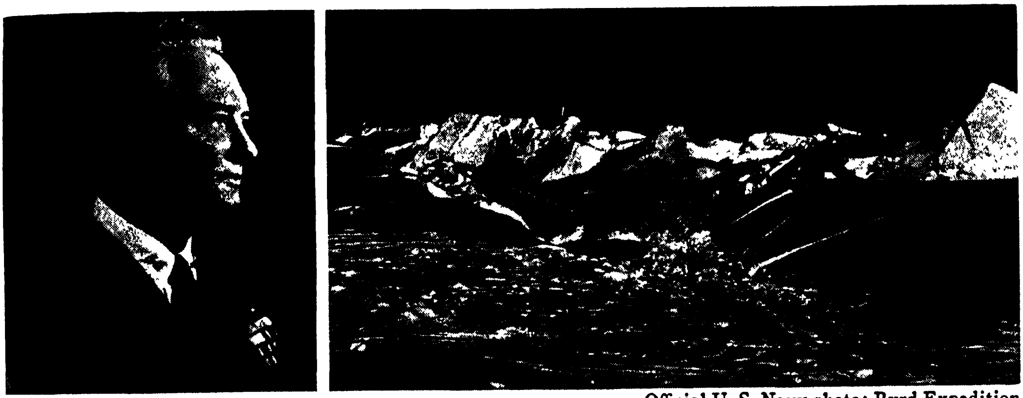
Another section of this expedition was to have met Shackleton on the Ross Sea side of the Antarctic continent. It succeeded in laying depots, but its ship, the Aurora, was swept into the pack ice in May, 1915, leaving a party of nine stranded on the mainland. The Aurora did not get free until nearly a year later. The leader and two others perished.

SHACKLETON'S EXPEDITION IN THE QUEST AND HIS DEATH AT SEA

Sir Ernest Shackleton set out on another voyage, in the Quest, in September, 1921. However, he had overstrained his heart and died at sea four months later. He was buried in South Georgia, that little island just short of the Antarctic Circle which had witnessed one of the most heroic of his many feats of knight-errantry and splendid resource. Frank Wild, his second in command, carried on the expedition.

For several years after Shackleton's death Antarctic exploration lagged. Then, in 1928, a new era dawned and several assaults began to be made on the great desolate continent. Sir George Hubert Wilkins, the aviator, took his plane to Deception Island and on December 20, 1928, was the first to fly in the Antarctic. He returned a year later and made several more flights to Graham and Charcot lands. Altogether he flew about 6,000 miles and discovered 14 islands and 1,500 miles of coastline.

It was found that the airplane increased the scope of Antarctic exploration a hun-



Official U. S. Navy photo; Byrd Expedition

Admiral Richard E. Byrd, USN. Right, a picture taken on the snowy wastes of Antarctica, during one of his expeditions. In 1929 Byrd named Little America, where he camped. Byrd made three later trips to the Antarctic.

Byrd Expedition

A view of the camp at Little America, showing the living quarters, buildings for work and (left) airplane.

dredfold. Where men had once plodded wearily over the ice for weeks, the plane in a few hours smoothly and accurately took in thousands of square miles.

Admiral Richard E. Byrd, of the United States, who had already flown over the North Pole, used airplanes on each of his four expeditions to the Antarctic. His first trip, made in 1928, was by far the best equipped of any up to that time. Every foreseeable emergency was provided for. There were several scores of picked men and it took four ships to carry the expedition to its base. This was established on the Ross Ice Barrier at the Bay of Whales and named Little America. Several buildings and hangars, some of them dug into the ice, were built, as well as a large radio station, through which the expedition always stayed in touch with the outside world. Here, 2,300 miles from the nearest human habitation, 42 men spent 14 months.

Though the chief aim of the expedition was scientific, its highlight was Byrd's flight to the South Pole on November 29, 1929. With Bernt Balchen as pilot, Harold I. June as radio-man and Captain Ashley C. McKinley as aerial photographer, Byrd set out from Little America in the tri-motored monoplane, Floyd Bennett. There was trouble in crossing some high mountains, but the Pole was reached without incident and a United States flag was dropped there. To honor Amundsen and Scott, flags of Norway and England were also dropped and a French flag in token of the warm reception Byrd had received on his transatlantic flight. Nineteen hours after the start the flyers were safely back in Little America with which they had remained in unbroken radio communication.

When the expedition returned in 1930 it had mapped 500,000 square miles of territory—200,000 of it never before seen—made 23 flights and collected a vast amount of scientific material. Three years later Byrd led a similar, larger expedition. Four airplanes, including an autogiro, were taken along, as well as five tractors. Little America was dug out again and enlarged after there had been much trouble and danger in unloading and transporting a million pounds of stores. Byrd himself elected to stay five months completely alone at an advanced weather station 123 miles south of Little America, where he nearly died of poisonous fumes from his stove before relief came. This time the whole world could listen in on the expedition and millions heard the radio broadcasts to and from Little America.

As in the previous expedition, many flights were made and much territory was mapped and explored. Several sledging journeys were undertaken, one to within 183 miles of the South Pole. Important exploration was carried out by ships and by plane operating from the ship. To give an idea of the scientific work, here are some of the fields of science covered: the weather, astronomy, biology, zoology, botany, geology, physics, magetism, bacteriology, glaciers, map-making.

ADMIRAL BYRD'S THIRD AND FOURTH EXPEDITIONS

Byrd set out on his third expedition in 1939, this time on behalf of the United States Government. This official trip had three purposes. The first was to explore a vast area south of the Pacific Ocean, between West Longitude 80° and 150°. In spite of previous explorations by Byrd and another American explorer, Lincoln Ellsworth, most of this territory remained to be studied. The second purpose was to strengthen United States' claims through continuous occupation; so it was planned to establish bases with permanent crews. The expedition also was to make scientific studies in the area.

A west base was set up near Little America, southwest of New Zealand, and an east base some 1,400 miles away, south of Cape Horn. Fifty-eight men were divided between the two bases, to conduct scientific research. Plans, however, were cut short when Congress refused to appropriate more funds, and the expedition was ordered home in 1940.

The fourth expedition in 1947 was also sponsored by the American Government, and was called Operation Highjump. It was the largest expedition ever to attack the great, white Antarctic continent. There was 4,000 men in the party, many ships and airplanes, and huge amounts of supplies and equipment, such as tractors and bulldozers.

One of the principal purposes of the expedition was to locate and map unknown portions of the coastline. More than 5,400 miles of coast, not counting many small bays and inlets, were actually defined or proved. Another aim was to set up a base from which planes could operate in mapping the interior with cameras. In all, an area of over 300,000 square miles—200,000 of which had never before been seen by anyone—was covered on these mapping flights. Ten new mountain ranges, some with peaks as high as 16,000 and perhaps 20,000 feet, were discovered. Strange, ice-free areas were discovered, one 300 square miles in diameter. Scientists studied such things as the earth's magnetic field and the speed of sound through different forms of ice. Cold-weather equipment was put to severe tests. On February 15, Admiral Byrd made his second flight over the South Pole.

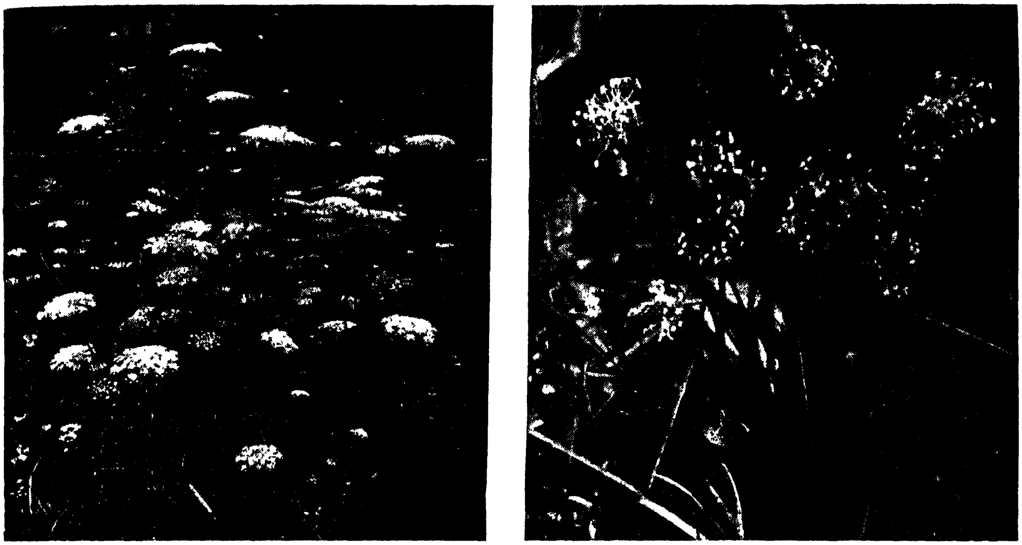
Another American explorer has also attempted to fly over the South Pole. Lincoln Ellsworth and Sir Hubert Wilkins set out early in 1934 to fly across the Antarctic continent, but their plane was damaged by ice. In 1939, Ellsworth, with J. H. Lymburner as his pilot, explored a vast Antarctic tract south of the continental barrier in the Eastern Hemisphere; he laid claim to this territory for the United States.

COMMANDER FINN RONNE EXPLORES THE WEDDELL SEA

In 1947, Commander Finn Ronne (U. S. N. R.) led a small group of scientists to the Weddell Sea area to explore, map and study. Mrs. Ronne was also a member of the group, becoming the first woman to set foot in the Antarctic. The Ronne expedition, with two small planes, flew over about 250,000 square miles of unknown territory and proved one very important thing—that the Antarctic is one continent, not divided by a body of frozen water as had been thought.

Unofficial United States claims in Antarctica involve some 1,000,000 square miles, all within the Western Hemisphere. Claims, official and unofficial, to areas in Antarctica have been made by nine countries—the United States, France, Soviet Russia, Germany, Norway, Great Britain, Argentina, Chile and Japan. Some international agreements have been made, but many questions remain unsettled. The matter of United States' claims has involved discussions with Chile and Argentina. Naval bases in Antarctica would be very important to the United States.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 5481.



L. W. Brownell

Two common meadow weeds are the wild carrot, known also as Queen Anne's lace, at the left, and English plantain, on the right. Wild carrot often grows up in hay fields after they have been mowed, making a sea of white foam.

Roadside PLANTS *and* WEEDS

Did you ever see an abandoned farm? A house with sagging windows and with gray cracked wood showing through the remaining flakes of paint. A barn whose loose boards let you see the darkness inside. And everywhere weeds, hiding the fences, pushing their way up through the planks of the porch, swaying merrily in the wind where the flower garden used to be. Little weeds, such as purple-flowered selfheal, thriving in the cracks between the bricks of the path to the front door. Tall weeds, such as milky-juiced wild lettuce and rough-leaved giant ragweed, competing for space in the abandoned cornfield. Bindweed with flowers like morning-glories twisting around the fence-rails; and dozens of others. Sometimes you even find chickweed and rushes blooming contentedly in half an inch of soil in a cracked shingle on the roof or in the corner of a window ledge.

If you walk along a country road or a neglected street in the city you notice that many of the weeds are the same. Although they are a great nuisance when they grow where we don't want them, many of these weeds and other roadside plants are actually quite lovely. Among the most beautiful sights in the United States and Canada in late summer and early autumn are roadsides brimming with yellow goldenrod and white and blue asters. Just as attractive are the buttercups of spring and summer, the butterfly weed with its clusters of bright orange, and the Deptford pink with its narrow leaves and crimson blossoms gleaming through the grass.

To the farmer many of these roadside plants seem much less attractive than they do to the man or child who is strolling by or driving along enjoying the view. For the farmer has to fight a perpetual battle with the weeds which are only too willing to crowd out the crop plants.

What is a weed? A weed is a plant growing where it is not wanted. White mustard is grown as a crop for its little yellow seeds which are ground up to make the hot brownish "mustard" which some people like on their food. So, sometimes, mustard is a useful plant. But when it grows along with its cousin, the wild mustard, uninvited in grain fields, it is competing with the grain plants for water, space, light and mineral matter. Then it becomes a nuisance and is considered a weed. Other cultivated plants, such as radishes and parsnips, frequently "run wild" and grow as weeds in grain fields and gardens, doing harm rather than good.

The sweetbrier, a European rose with pink flowers and sweet-scented leaves is one of the many garden flowers brought to America. It is the eglantine of the English poets. But when the sweetbrier crowds the grasses and clovers out of a pasture it becomes a weed.

HOW WEEDS RUIN CROP AND GARDEN, TAKING AWAY NOURISHMENT FROM OTHER PLANTS

What harm do weeds do? First of all, they take water and nourishment from the soil and thus deprive the crops of food. They also compete with the cultivated plants for space and light. Twining weeds, such as bindweed, twist their stems around the crop plant, shading its stem and leaves, and preventing its leaves from developing properly. Sometimes the weeds are so heavy that they pull the cultivated plants down to the ground. One of the worst of all weeds, dodder, curls its yellow or reddish fleshy stems around its victim and then lives as a real parasite. It sends suckers into the body of the crop plant and draws out water and food through these suckers.

Another harmful thing that weeds do is to encourage the growth of insect pests and plant diseases. The wild mustard harbors the turnip fly and the turnip gall-weevil. These insects feed on the wild mustard until the turnip plants come up, then they invade the turnips. Mustard also harbors the cabbage-root maggot and the spinach aphid. The wild carrot serves as a home and a food supply for the carrot weevil. When the cultivated carrot plants start to grow these insects move over and attack the cultivated carrots.

Many weeds serve as hosts for various fungi, bacteria and viruses which cause plant diseases. Several weeds are poisonous to livestock, such as death camass and the loco weeds of the West. Some annoy man very directly, including poison ivy and the various weeds which cause hay fever. Some weeds damage food products by getting into them in one way or another. When cows feed on wild onion the milk has an unpleasant flavor, rather like garlic. When seeds from corn cockle get harvested with wheat they cause the flour to produce flat, unpalatable bread. In general, weeds cause a reduction in the yield of crops and make it more expensive to operate a farm.

Do weeds do any good? Yes. Many weeds can be eaten by animals when nothing better can be obtained. Wild birds depend on weed seeds for food to a considerable extent, especially those of weeds like pigweed and lamb's-quarters, whose seeds frequently cling to the dead stems, even when the ground is covered with snow. Several of the commonest weeds are excellent when cooked for greens. Anyone who likes spinach should like lamb's-quarters, pokeweed, purslane and wild mustard. Most important, weeds hold soil in place and help to check erosion. They do not do as good a job at this as trees or certain grasses, but a weed cover protects the soil against heavy rains and winds much better than no cover.

When we see dandelion flaunting its golden blossoms on the lawn, or when we find ten ragweeds for every cornstalk in a cornfield, it almost looks as though Nature had speciallly favored the weeds in their struggle for existence. It is true that weeds are adapted in different ways to thrive in spite of all of our efforts to control them.

Some weeds have become the companions of certain cultivated plants because they take about the same length of time to develop, thrive under the same conditions and, most important, have seeds which can not be separated readily by the machines used for cleaning seed. Wherever winter wheat is grown, the purple-flowered corn cockle is found in the wheat fields, because its seed so frequently gets harvested along with the wheat.

HOW THE BUTTERCUP IS ABLE TO LIVE IN PASTURES

Many weeds thrive under worse conditions than crop plants can well endure. Those weeds which have leaves and stems modified so as not to lose much water to the air may win out against other plants when there is not enough rain. Some weeds survive by making themselves unpleasant. In a pasture the cattle will not eat spiny thistles as long as more toothsome plants are growing. Animals also usually refuse to eat buttercups because these beautiful plants contain a disagreeable, irritating juice.

Some weeds can even continue to produce flowers and seeds after they have been pulled up. Purslane and chickweed, for instance, may continue to live and produce seeds for days after being uprooted. Other weeds will produce seeds in two ways after the plants have been beheaded. New stems will grow up from the lower part which is still in the soil; these stems, of course, will bear flowers and seeds. The mowed-off tops of such weeds as sow thistle and curly dock will frequently ripen seed as they lie on the ground with no connection to the soil.

A great many weeds have seeds or fruits with structures to help them get to new territory. The seeds of dandelion, wild lettuce, milkweed and many others ride lightly through the air on their downy parachutes. Other seeds, like those of cocklebur and burdock, have spines, or hooks, by which they cling to animals. However, some of the worst and most widely distributed weeds, such as ragweed, have no special structures for securing free rides for their seeds.

We can classify weeds according to how long they live. Plants (like the eastern ragweeds) which live only one season and die after maturing their seeds are called annuals. Those which live through two summers are biennials. The dainty Queen Anne's lace (wild carrot), which causes so much trouble in hay fields, is a biennial. Plants whose underground parts live on, year after year, are perennials. Dandelion, chicory, asters and goldenrods are perennials.

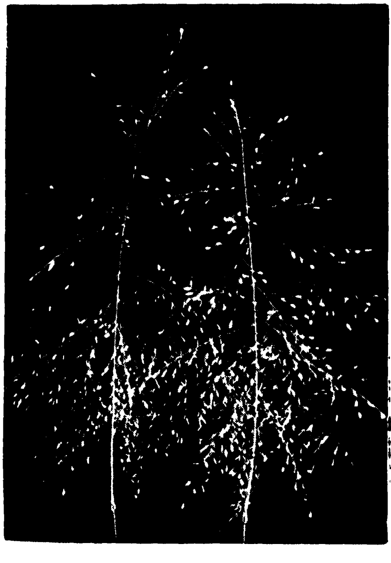
Many of the worst weeds of cultivated soil are annuals. Whenever the soil is disturbed, or the vegetation that is already there is destroyed, the seeds of annual weeds get a chance to sprout. If you dig up a square foot of roadside soil, put it in pots and water it, you will be astounded at the number of weed seedlings which sprout from seeds already in the ground.

Most weeds produce an abundance of seeds, but the numbers produced by some annuals and biennials are astounding. One plant of fleshy-leaved purslane may produce 190,000 seeds in one summer. Tumbleweed may drop 180,000 seeds as it bounces over the western plains. There is a case on record of one tumbleweed which produced 11,000,000 seeds! One amaranth plant (pigweed) has been known to produce more than 196,000 seeds. One plant of hedge mustard may produce over 500,000 seeds, which is more than enough to supply one hedge mustard seedling for every square yard of a 100-acre farm. One of the champions at seed production is a biennial, the beautiful foxglove which is grown both for its flowers and for the drug digitalis. Before it dies at the end of its second summer, one digitalis plant may produce more than a million seeds.

Courtesy, Boyce Thompson Institute for Plant Research

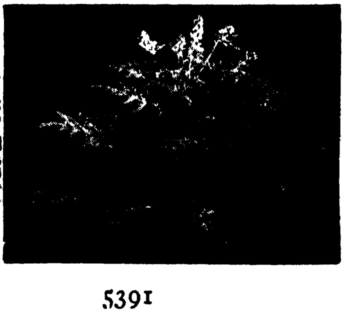
Yellow-flowered purslane.

Where the ground is regularly plowed or spaded, the annual weeds have an advantage. The underground parts of the perennial weeds are broken up or disturbed; while the cultivation of the soil improves conditions for the growth of seedlings—weeds and crops. So the first weeds to come up after the soil is disturbed are usually annuals or biennials. But if the soil is left undisturbed for some time, as in the case of a permanent pasture or meadow, the annual weeds are usually eventually crowded out by perennial weeds which store food in their deep roots or underground stems. The young springtime shoots of perennial plants such as the asters and goldenrods, dandelions and chicory, live on this stored food



L. W. Brownell

Shown at the left is a familiar tumbleweed.



Courtesy, Boyce Thompson Institute for Plant Research, Inc.

The common ragweed, the worst offender in causing hay fever.

until they are large enough to make their own food. In the eastern United States and Canada you will almost never see a ragweed, pigweed or lamb's-quarters in a permanent meadow. They have been crowded out by the asters, buttercups, oxeye daisies, goldenrods and other perennials. This is in spite of the fact that the giant ragweed grows much taller than most other weeds, sometimes towering fifteen feet high.

We have said that annual weeds gain an advantage when the ground is cultivated. Often, however, when fields are plowed and harrowed the roots and underground stems of perennial weeds like perennial sow thistle, Canada thistle, blindweed and chicory, may be cut into small pieces, each of which is capable of producing a new plant. The result may be that a weed which was originally present on only a small part of the field may be scattered widely.

Perennial weeds spread aggressively by pushing their underground stems outward in every direction from the parent plant, so that in a few years there will be a large group of new weeds that have sprouted from a single parent plant.

Weed seeds often remain in the soil alive for many years and then sprout when the soil is plowed or disturbed in some other way. Seeds of pigweed, purslane, lamb's-quarters and black mustard have been known to germinate after having been buried from twenty to forty years.

Perhaps the most important thing in preventing the spread of weeds into new areas is the use of clean seed. By clean seed we mean seed which does not have weed seeds mixed in with the crop seeds. Another important measure is to clean all threshers and other farm implements after using them in fields infested with weeds. Mowing weedy meadows helps to prevent wind-blown weed seed from invading near-by fields.

Weeds can be pulled up by hand or destroyed by hoeing, but this method takes much time. Plowing, harrowing and disking help to keep cultivated crops free from weeds. The right amount of grazing by cattle, especially sheep, is one of the best ways of keeping down weeds in pastures and along fence rows. Overgrazing is harmful, of course, and may actually encourage certain undesirable weeds when the nourishing grasses and clovers are injured. Other methods of weed control include burning, the use of hot steam along railroad lines, various chemicals, and covering the ground with a mulch (blanket) of straw or heavy paper which prevents the young weeds from growing through to reach the light. Proper rotation of crops is useful in checking weeds. Plants like alfalfa and sweet clover are often grown as "smother" crops because they grow so rapidly and in such a thick stand that the weeds are choked out.

Courtesy, Boyce Thompson Institute for Plant Research

A very common lawn weed is the dandelion.

Wherever civilized man goes, certain weeds accompany him. One of the most widespread, and one which we will find almost everywhere, is the dandelion. It thrives particularly in lawns and roadsides. What looks like a golden-yellow flower is actually a "head" of 150 to 200 tiny blossoms clustered closely together. If you examine the dandelion flower head with a magnifying glass you will see that each of the petal-like yellow rays is the corolla of a tiny flower. Give it a pull and the whole little flower comes out. As the dandelion seeds mature, each of these little corollas fades and withers away. Soon, instead of the golden flower there is a fragile gauzy white umbrella at the tip of each stem and a tiny seed at the other end of the stem. At the first gust of wind the umbrella and its seed take wing and sail off, each seed buoyed up by its parachute of delicate white bristles.

Did you ever try to rid a lawn of dandelions? Mow the tops off and the remaining leaves grow close-pressed to the earth. Cut the top off at ground level, and the top of the root promptly heals and sends up new shoots. You must dig the roots up, one by one, if you expect to clear your lawn.

The leaves of the dandelion are cut and jagged so that they form a rather beautiful design. The name dandelion comes from the French *dent de lion* (lion's tooth) from the curious shape of the leaves.

Every one who snaps off a dandelion stem to blow the seeds into the air notices that milky juice flows from the cut stem. This juice contains latex, which is the same substance from which we get rubber. A large dandelion named kok-saghyz helped to win World War II because the Russians cultivated it extensively for its rubber.

L. W. Brownell

Chicory (on the left), with its sky-blue flowers, often grows from one to three feet high. The other weed is burdock, with its small, sticky burs.

Closely related to the dandelion is another widespread weed, which is called chicory. You can recognize chicory by its flowers which look something like sky-blue dandelions. Sometimes the flowers fade to pink and sometimes they are white. Like the dandelion, chicory has milky juice and a deep tap root. The lower leaves are almost as jagged as the dandelion's, but the upper leaves are more regular in shape, with "toothed," or almost smooth, margins. Instead of clinging close to the ground as the dandelion does, chicory has numerous awkward branches from one to three feet high. The whole plant looks stiff and clumsy, especially when specked with dust or mud, but the big blue flower heads are beautiful even when they grow on the almost leafless tips of the stems.

The flower heads open wide on bright mornings, but usually close by noon, and also close in cloudy or rainy weather. Chicory is a troublesome weed in many places, especially in limestone regions, but it is grown in Michigan and in Europe for its roots, which are ground up to mix with coffee or to use as a coffee substitute.

Both chicory and dandelion belong to the great composite family of plants, all of which have flower heads made up of many tiny blossoms. These little flowers never produce more than one seed apiece.

The hawkweeds are milky-juiced composites with handsome flowers which are sometimes mistaken for dandelions. Farmers' opinions of the hawkweeds may be indicated by such names as king devil, felon herb, yellow devil, and devil's paintbrush. About thirty-six species occur in Canada and the United States. Of these, several are troublesome weeds. The mouse-ear hawkweed has golden-yellow flowers. The leaves are hairy, with a felt of star-shaped hairs beneath, and are all attached at the base of the flower stem. There is usually only one flower head to a stem. The orange hawkweed, or devil's paintbrush, is similar, but with several orange-red heads at the tip of each stem.

One of the tallest of all weeds is a first cousin of the common salad lettuce. The tall blue lettuce is a slender, stately plant that sometimes grows twelve to fifteen feet high in one season. It has numerous small flower heads with pale blue or white flowers. Other species of wild lettuce have yellow flowers. Closely related to wild lettuce are the sow thistles which grow from two to ten feet high and have rich-looking prickly margined leaves and yellow flowers. Two species of sow thistles are annuals, but the most troublesome species is a perennial.

The sow thistle is not really a thistle. One of the worst of all weeds is the Canada thistle, a real thistle. In spite of its name, it is not a native of Canada, but of Europe. However, it has spread almost everywhere in southern Canada and the northern United States. Like other thistles, the Canada thistle has jagged leaves with many sharp points. It has many flower heads, each of them a little less than an inch in diameter. The flowers may be rose-purple, lavender or white.

The Canada thistle is a general pest in grain fields, cultivated fields, meadows and pastures. Thirty-seven states have declared it by law a noxious weed (yes, plants may be outlawed!). One reason Canada thistle is so difficult to get rid of is that every fragment of its creeping root can give rise to a new plant.

Another weed of the composite family which emigrated from Europe is the oxeye daisy whose blossoms turn whole meadows white in June and July. The scientific name of this daisy is *Chrysanthemum leucanthemum* and it is closely related to the chrysanthemums of the garden. We know it simply as the daisy.

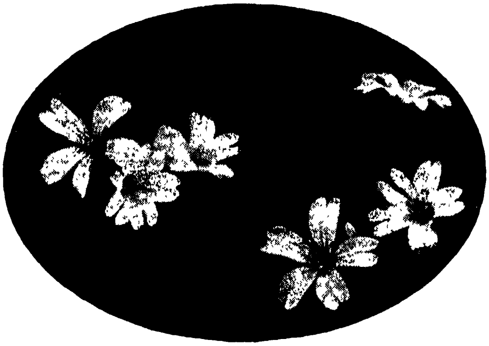
Yarrow is another handsome roadside plant that is always ready to invade lawns and pastures. Before the flowers appear, yarrow, with its finely divided leaves, looks a good deal like a fern. The small heads are in flat-topped clusters. The heads have yellowish or gray centers with four to six white rays.

Wherever farmyards are neglected we are likely to find burdock, a much branched weed whose leaves are large and often heart-shaped. Burdock has pinkish purple flower heads which look a little like thistles. When the seeds ripen the whole flower head comes off to hook itself firmly to any passing animal's coat.

The composite family includes many other weeds. Among them is a tribe of real criminals, if we may apply that term to a plant. These are the ragweeds, which are the most important of all the causes of hay fever. All the plants mentioned so far have handsome brightly colored flowers and are pollinated by insects. Ragweed, however, has tiny, green, inconspicuous flower heads. The flowers are pollinated by the wind and produce pollen in vast quantities. August and September, when the ragweeds are in flower, are months of misery for those allergic to this pollen. (See Allergy in the Index.) Unfortunately the victims often suspect perfectly innocent flowers—asters, buttercups and daisies. It is a good thing that the eastern ragweeds are annuals, and that the perennial plants gradually crowd the ragweeds out whenever the ground is left undisturbed.

Short ragweed is a much branched plant with beautifully divided leaves. Giant ragweed is a much taller plant, very coarse and hairy. The whole plant feels rough to touch. It usually stands from three to eight feet tall, but a specimen was once measured which was eighteen feet long. The big, flat leaves are usually divided into three lobes. Two leaves always grow out opposite to each other at each node of the stem.

After the first crop of hay has been mowed from a meadow, the whole field often takes on the appearance of a billowing sea of white foam. This means that the field is infested with wild carrot, often called Queen Anne's lace. The flowers are in disc-shaped clusters at the tips of slender stems, the blossoms forming a delicate pattern. In the center of the cluster there is usually one tiny deep purple blossom amid all the white ones. When the flowers fade the plant is less attractive, because the maturing flower cluster curls up until it resembles a bird's nest and then dries up and frequently breaks off from the dead stem, to be bounced along the autumn fields by the wind, dropping seeds like a small tumbleweed.



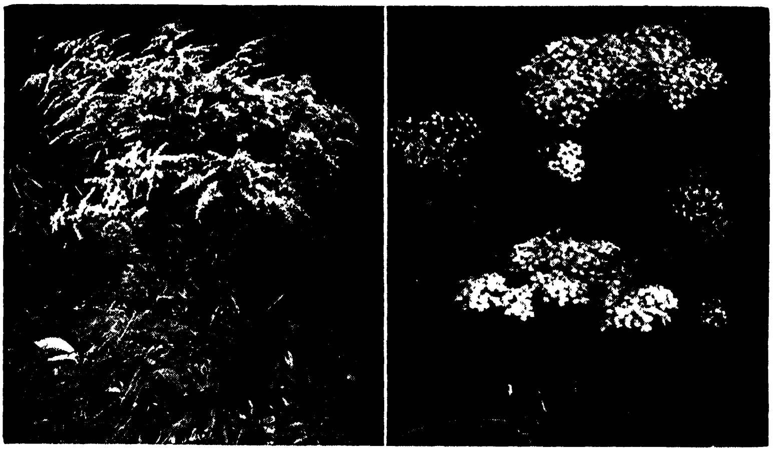
L. W. Brownell

Chickweed is very common throughout North America.

A tumbleweed is a weed which dries up in the fall and is then blown hither and yon by the wind, scattering its seeds as it goes. Sometimes the dry stem breaks off at the base and sometimes the whole plant is uprooted. The troublesome Russian thistle (which is not a thistle), abundant in the dry regions of the western United States and western Canada, is a tumbleweed. It belongs to the goosefoot family. Belonging to the pigweed family is another species which is known simply as tumbleweed. It is most abundant in the same regions as Russian thistle, but is sometimes abundant on truck farms in the East. Both species have small greenish flowers. The stems of tumbleweed are whitish, while those of Russian thistle are often reddish or red-striped.

Butter-and-eggs is almost too pretty a flower to be called a weed; but this slender little plant grows where it is not wanted, in grain fields, meadows, pastures and with cultivated crops, on both sides of the ocean.

The flowers are almost exactly like small yellow snapdragons, except that the base of the flower has a long, spur-like projection instead of being rounded as in the snapdragon. As with the snapdragon the lips of the flower are pressed together. This is an adaptation for being pollinated by bees. Lighter insects can not pull down the lower lip of the flower. This flower is often called yellow toadflax or ramstead.



L. W. Brownell

Goldenrod, left, and yarrow, right, are often seen along country roads.

A much richer yellow than that of butter-and-eggs is the polished gold of the buttercups. Buttercups are abundant in nearly all temperate and cool regions; they are among the last flowering plants left behind when climbing mountains or going toward the North Pole. A full-grown plant of the Arctic buttercup has a creeping stem a few inches long, with flowers and leaves not lifted more than half an inch above the ground. The buttercups of our meadows and swamps are much larger, of course; but they all have blossoms of the same type with five green sepals, five or more glossy petals, many stamens, and numerous pistils arranged like a cone. (See page 510.) The nectar is secreted in a little depression at the base of each petal. One of the commonest buttercups is the meadow, or tall field, buttercup, a European plant which often overruns pastures in America.

Botanists call the family that includes cabbage, radish, mustard and turnip the cross-bearing family, because the flowers always have just four petals in the shape of a Maltese cross. Wild parsnip and wild radish are among the weeds in this family. Much worse than these is the charlock, also called wild mustard, or field mustard. If you know what a turnip plant looks like when it goes to seed, you will recognize the charlock, since these two are closely related and look very similar. Like turnip and cabbage, charlock and the other mustards have light yellow flowers. The leaves of charlock are not definitely lobed like those of the black mustard, the white mustard and the turnip.

Other common weeds in the cross-bearing family are the shepherd's purse, a small plant with tiny white flowers and green, heart-shaped seed-pods. Even commoner than shepherd's purse is the wild peppergrass which grows along roadsides almost everywhere, frequently covered with dust. It is not a very attracive plant, with its numerous peppery seed-pods clustered to form a sort of cylinder at the tips of the stems. The very small, white flowers are at the tips of the columns of seed-pods.

The corn cockle that infests wheat fields belongs to the pink family, and is closely related to the sweet William and the carnation. Like the carnation, the corn cockle has a straight, hard, green stem; but the stem and leaves of the corn cockle are densely hairy. The lance-shaped leaves are in pairs. Seen from above, the five woolly green lobes of the calyx project beyond the purplish petals like the arms of a starfish. The black seeds will spoil flour if they are mixed with the wheat; and they are poisonous to stock and poultry.

Another poisonous plant is the black nightshade, which belongs to the potato family. It is a small plant, growing along fence rows and in shady places. The tips of the five small white petals bend backward. The whole plant is poisonous, but certain forms are cultivated for their juicy round black berries which are used in preserves after being cooked. A more important weed of the same family is the horse nettle which is frequently a nuisance in pastures and cultivated fields. The horse nettle has stout branches and lobed leaves. Both branches and leaves are covered with stiff little star-shaped hairs and are also protected by numerous yellowish spines. The flowers are white or pale violet and the numerous fruits are round orange berries.

A most attractive weed is the bindweed or field convolvulus, a first cousin of the cultivated morning-glory which it closely resembles. It is a very hard weed to get rid of, since the underground stems are always ready to send up dozens of new shoots.

Those yellow or pink parasites, the dodders, have been declared noxious weeds by the seed laws of forty-two American states. A dodder plant has no leaves, but it bears an abundance of small, pale flowers. Dodder attacks cultivated plants, and the various species are parasites on many other weeds. Some even grow on woody shrubs.

We often notice weeds like dandelion crowding out grass, but some of the worst weeds are themselves species of grass. Quack grass is a very ordinary looking grass, but it is one of the worst pests of cultivated fields. Perhaps you have heard of "sowing wild oats" which means doing foolish things that one will regret later. Real wild oats is a grass very similar to cultivated oats; yet the wild oats is a bothersome weed. A much more impressive member of the grass tribe is Johnson grass which has become one of the worst pests of the warmer parts of the United States. Johnson grass forms tropical looking thickets, its stout stems sometimes being six feet tall. Like some other plants which have become weeds, Johnson grass was brought to America purposely and it is grown extensively for forage and hay. A number of other grasses, such as old witch grass, crab grass and others, grow as weeds in lawns, gardens and fields.

Some time after the first settlements had been made in the northern United States and Canada, the Indians began to call a coarse-leaved weed white man's foot. This was the broad-leaved plantain which they noticed spreading along trails used by the settlers. Today it is one of the commonest weeds in waste places, especially in city lots and on the edges of playing fields. Broad-leaved plantain has thick leaves that hug the ground. The flower spikes stand straight up. Each individual flower is tiny and inconspicuous. Another species of plantain, the English plantain, has narrow leaves and all of its flowers are clustered at the tops of bare stems. The psyllium seed which people swallow to add bulk to their diet is from a species of plantain.

By THOMAS G. LAWRENCE.

SOME OF THE COMMON ROADSIDE PLANTS

with milky juice:

Dandelion, Chicory, Wild Lettuce, Sow Thistle, Hawkweed, Salsify, Milkweed (the Butterfly Weed is a milkweed), Flowering Spurge, Cypress Spurge, Creeping Spurge.

with green, brownish or very inconspicuous flowers:

Ragweed, Pigweed (Amaranth), Lamb's-Quarters (Goosefoot), Tumbleweed, Russian Thistle, Plantain, most Grasses, Cocklebur, Knotweed, Dock, Creeping Spurge, Pokeweed, Wormweed.

with white flowers:

Oxeye Daisy, Yarrow, Wild Carrot, Black Nightshade, Horse Nettle, Shepherd's Purse, Wild Peppergrass, Bladder Campion, Corn Gromwell, Corn Camomile, Bindweed, Sweet Clover (White Melilot), White Clover, Catnip, White Field Aster or Frostflower, Fleabane.

with yellow flowers:

Dandelion, Wild Lettuce, Sow Thistle, Mouse-ear Hawkweed, Butter-and-Eggs, Buttercup, Charlock, Turnip, Hop Clover, St. Johnswort (Klamath Weed is a St. Johnswort), Mullein, Moth Mullein, Marigold, Yellow Rattle, Yellow Camomile, Mousetail, Goldenrod, Yellow Melilot (Yellow Sweet Clover), Winter Cress, Agrimony, Wild Radish.

with orange flowers:

Butterfly Weed, Jewel Weed (Balsam or Touch-me-not), Hawkweed, Tansy, Ragwort.

with red flowers:

Scarlet Pimpernel, Cardinal Flower, Red Clover, Pheasant's Eye.

with pink flowers:

Persicaria (Lady's Thumb is a Persicaria), Red Clover, Dogbane, Bouncing Bet, Wild Rose.

with magenta or purple flowers:

Corn Cockle, Wild Geranium, Fireweed, Burdock, Canada Thistle, Alfalfa, some Asters, Prunella (Selfheal).

with violet flowers:

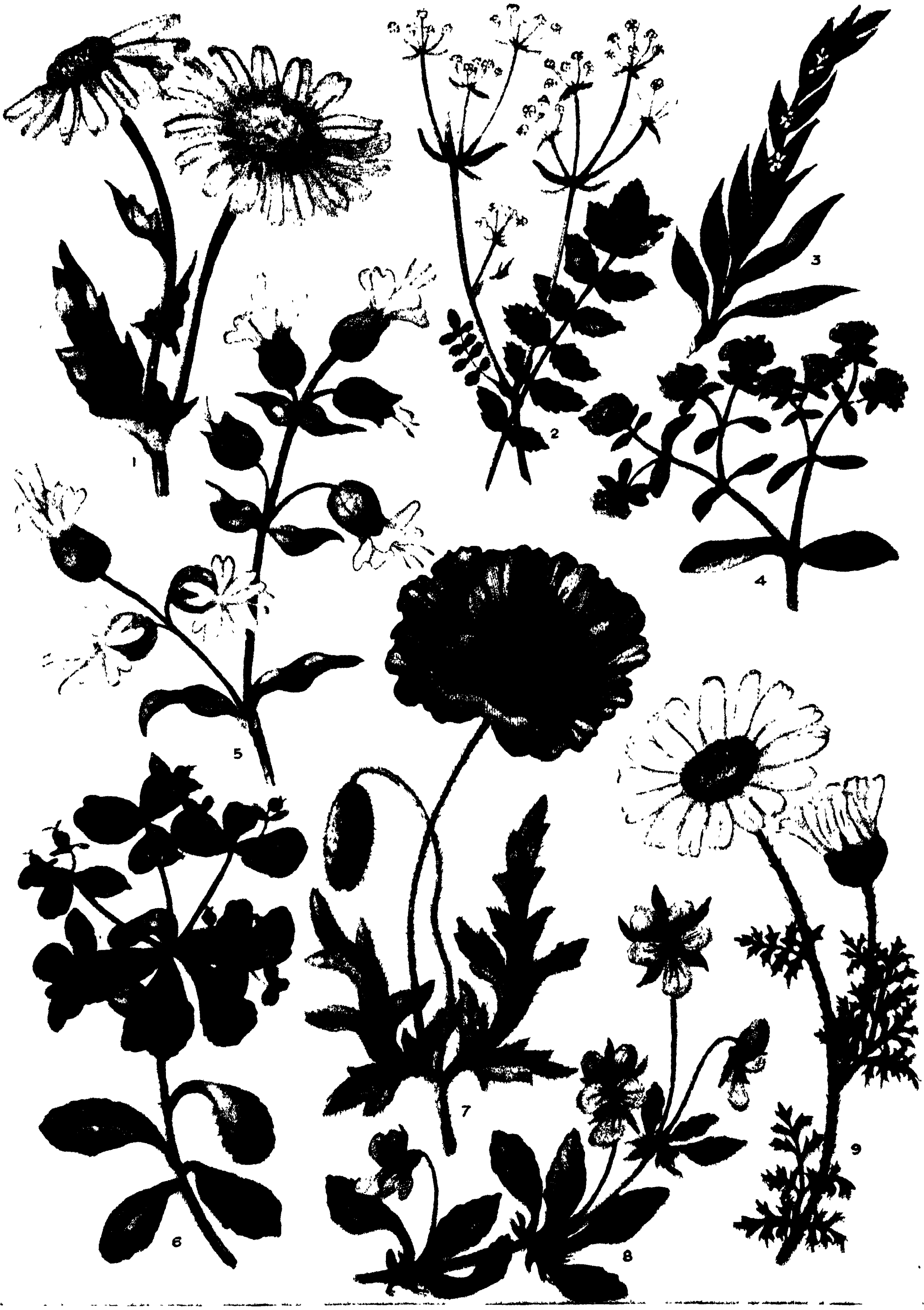
Lobelia, Violet, some Asters.

with blue flowers:

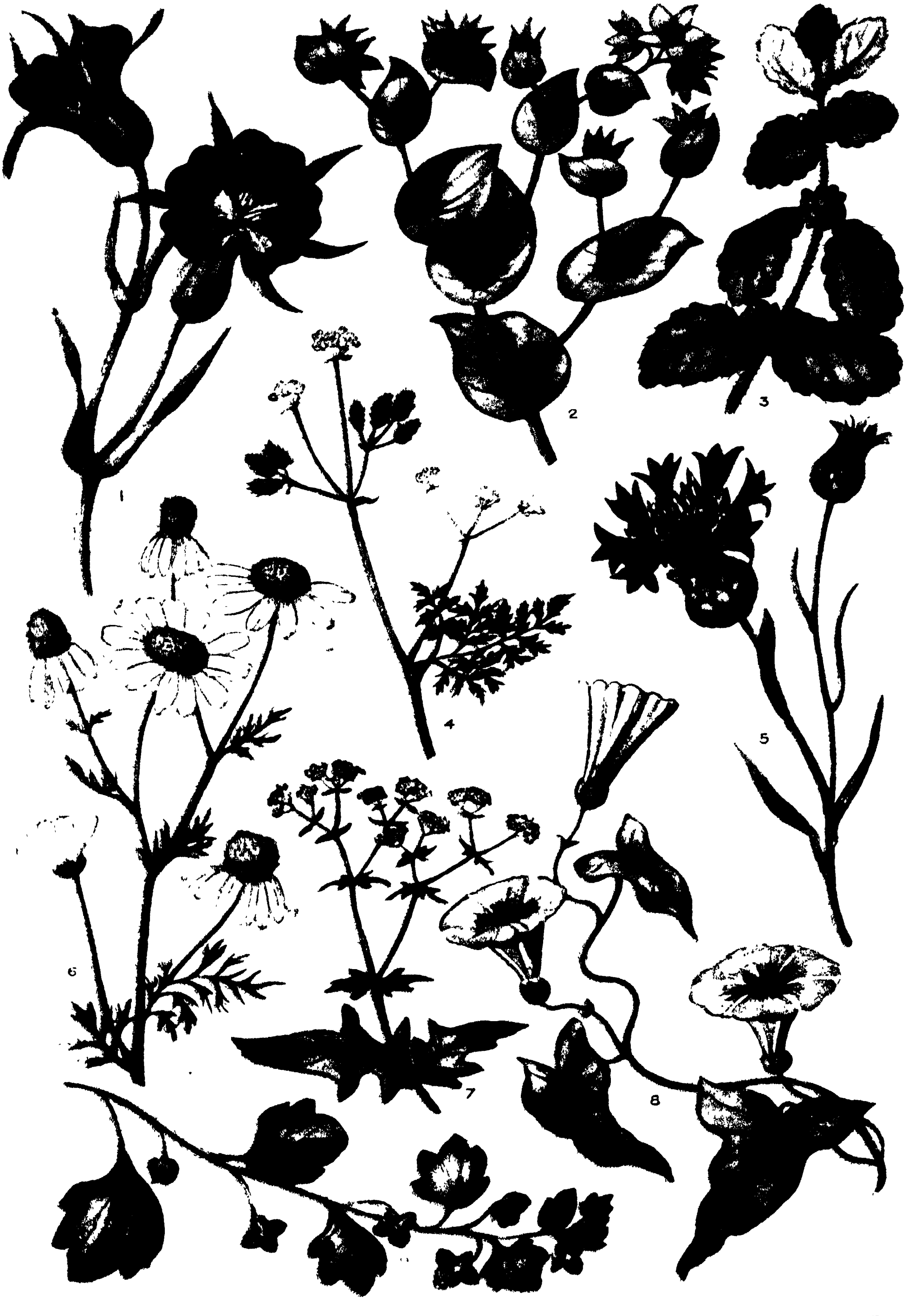
Chicory, Blue-eyed Grass, Wild Blue Lettuce, Blue Toadflax, Day Flower, Forget-me-not, Wild Morning-Glory, some Asters, Corn Salad, Cornflower, Blue Pimpernel.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 5601.

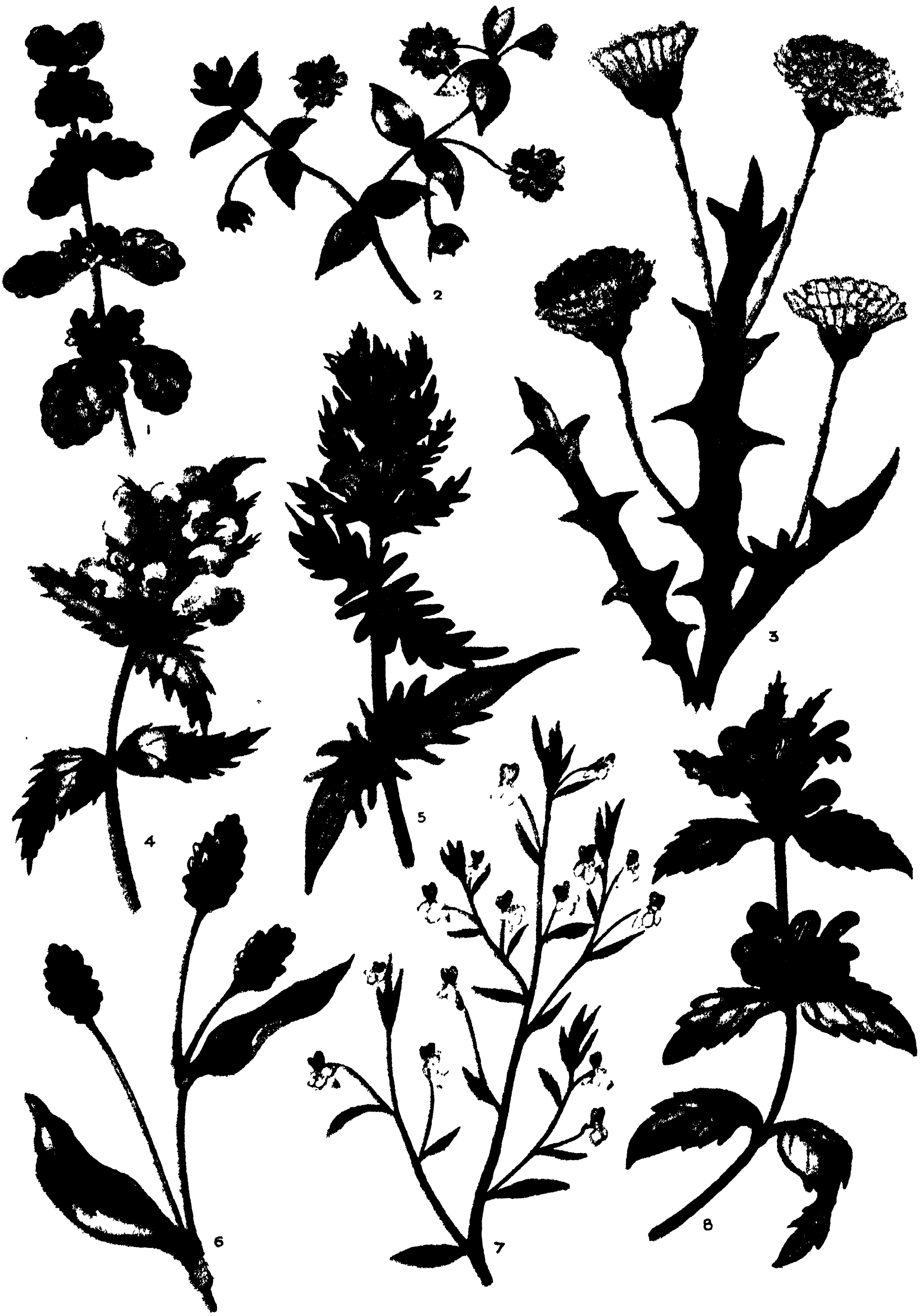
ROADSIDE PLANTS AND WEEDS



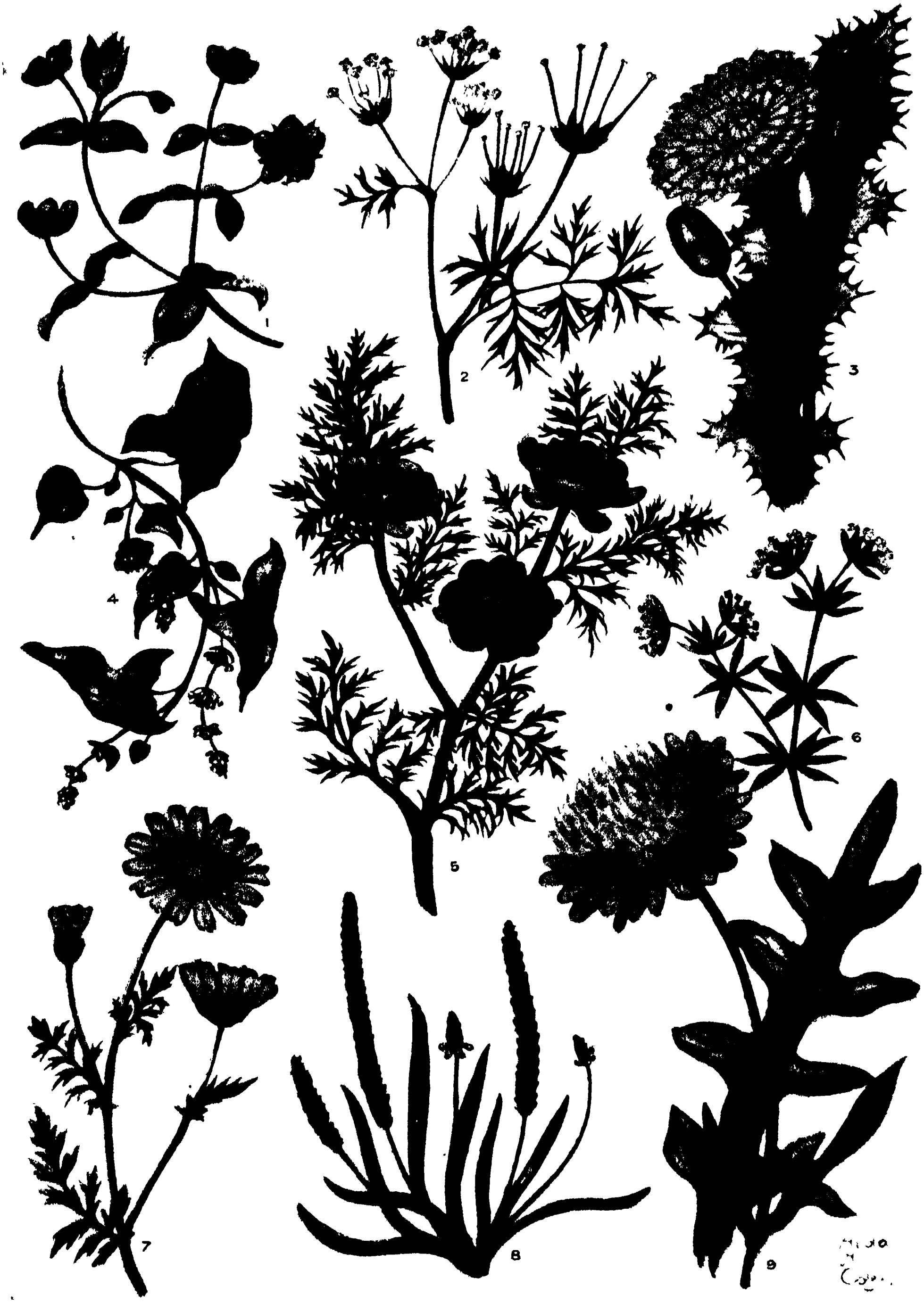
1. Corn Marigold. 2. Corn Parsley (E.). 3. Corn Gromwell. 4. Common Corn Salad (Rare).
5. Bladder Campion. 6. Sun Spurge (E.). 7. Red Poppy (E.). 8. Heartsease. 9. Corn Chamomile.
Plants marked (E.) are European and are not generally found in America



1. Corn Cockle. 2. Hare's Ear (E.) 3. Corn Mint. 4. Small Bur Parsley (E.). 5. Cornflower (E.). 6. Wild Chamomile. 7. Toothed Corn Salad (E.). 8. Field Bindweed. 9. Ivy-leaved Speedwell.

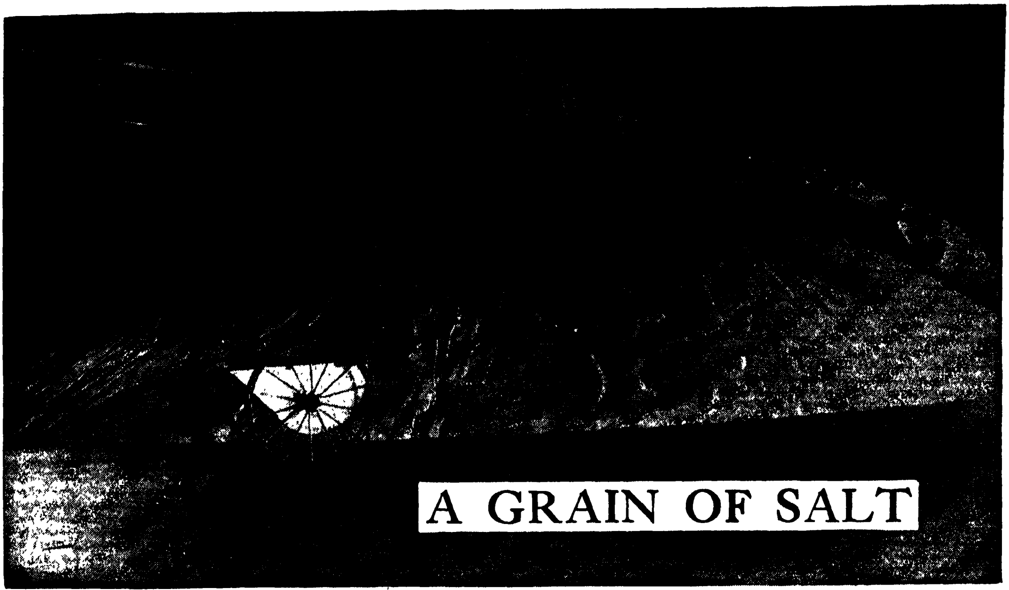


1. Corn Woundwort. 2 Blue Pimpernel. 3. Meadow Hawkbit. 4. Yellow Rattle. 5. Purple Cow-wheat (E.). 6. Pink Persicaria. 7. Small Snapdragon. 8. Red Hemp Nettle.



1. Scarlet Pimpernel. 2. Lady's Comb. 3. Sow Thistle. 4. Climbing Persicaria (E.). 5. Pheasant's Eye. 6. Field Madder (E.). 7. Yellow Chamomile. 8. Mouse Tail. 9. Field Scabious.

A GRAIN OF SALT



Courtesy, Diamond Crystal Salt Co.

THE salt in the kitchen or on the dining room table seems a very commonplace thing. Yet in each grain of salt there lies a story full of romance and wonder, a story which few of us know.

Many millions of years ago much of the world's present land surface lay under vast salt seas. Gradually the water of these seas dried up and left their salt behind them. During the ages that followed, the salt of the ancient seas became buried under many feet of earth, clay and rock. Today a large part of the world's salt supply comes from the great veins or beds of almost pure salt formed by this burying process. The other great source of salt is the water from salt springs, salt lakes, or, still more important, the seas. The Dead Sea, in Palestine, and Great Salt Lake, Utah, are so saturated with salt that one can not sink in the water. The Dead Sea is so salty that no life can exist in it.

Since the earliest times, man has been conscious of the necessity for salt in his daily life as an article of food. All human tissue requires salt, and blood can be replaced to a certain extent by a solution of common salt. Salt helps in making hydrochloric acid, which helps us to digest our food. An animal or a man with insufficient salt in his food grow feeble, and with no salt at all may die. Wild animals instinctively seek out salt pools or salt rock, "salt licks," often traveling great distances to reach them. Man, too, has gone great distances and undergone much hardship to secure a bountiful supply of it.

The Phoenicians, the great traders of the early world, established a regular commerce in salt. Salt from the great mines of India was carried to Mediterranean markets by camel caravans more than two thousand years ago. Some of the caravans routes of today originated as salt roads ages ago. The Via Salaria, which means Salt Road in Latin, is an Italian road which was used in ancient times to carry salt from the salt pans of Ostia, the port of Rome, into the neighboring country of Sabines.

The word "salary" shows the great value ancient man placed on salt. The term is derived from salt and in its original sense it indicated that money was given to buy salt. In other words, a Roman soldier's salt money was his salary. Until not so very many years ago, natives of Sierra Leone in Africa valued salt so highly that they were willing to sell their wives and children for it. A tax on salt has been levied in many countries. A few years ago the British government in India attempted to increase the salt tax. Rebellion was threatened and the

Courtesy, International Salt Co., Inc.

Much salt is secured by pumping brine from underground wells, and evaporating the water. The scene above is at Ludlowville, New York. The brine is drawn from deep wells, not unlike oil (see the derricks), and stored in tanks.

extra tax was removed the following year.

We no longer pay salaries in salt, but we still recognize its great importance. However, nowadays it is such a cheap and common thing that we are inclined to give little thought to its origin and history, or to the methods by which it is obtained.

Common salt, or sodium chloride, is composed of the elements sodium and chlorine. Sodium is a curious soft metal which can be cut with a knife and is very difficult to keep pure. Chlorine by itself is a deadly gas, and it seems strange that it should form a basic part of a compound so vitally essential to human and animal life.

Salt and other compounds of sodium are to be found everywhere, and wherever salt or any compound of sodium exists, and is made hot, it gives forth a special kind of yellow light.

By passing any light through a prism we can clearly detect the bright yellow lines that mark the presence of salt, or, rather, of the sodium in the salt. It is only natural, then, to turn our attention to the light that reaches us from the sun and the stars. No sooner do we do so than we find that the material which is in our bodies, which abounds in the sea and which also forms a sort of rock upon the earth, is also abundant in the sun and in many of the stars.

The salt found in the seas is the accumulation of millions of years. Rivers flowing into the seas carry with them a certain amount of salt which has been washed from the earth through which the rivers pass. The amount of salt contained in the oceans is enormous. It has been calculated that there is enough to cover the whole surface of the earth to the depth of almost four hundred feet. This would be something like fourteen times all the solid land of Europe above sea level.

At one time a great deal of the salt used in the world was taken from sea water or from salt lakes. The simplest way of deriving salt from these sources was by the heat of the sun, or solar evaporation. Water from the sea or a salt lake was led into a series of shallow pools, where it evaporated, leaving the salt behind. The salt was then raked into heaps, and as soon as it was dry, it was ready for market. This method of obtaining salt has been known since very early times, and it is still used to a limited extent in some parts of the world. It is the cheapest way of making salt. However, salt so made is never free from impurities.

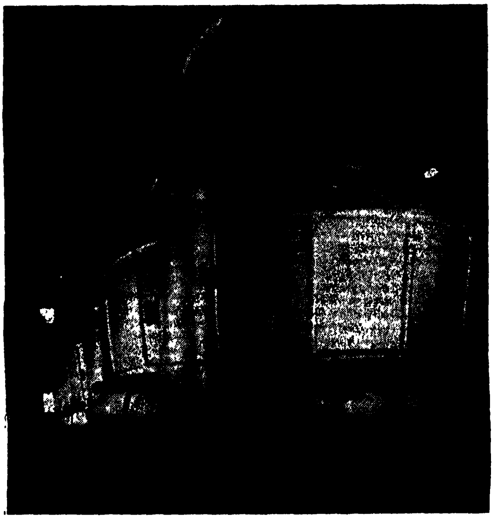
Much of the salt we use today comes from the great veins or deposits of rock salt which are buried deep under the ground. As we have seen, these deposits were formed by the drying up of ancient seas, which left their salt behind to be buried under layers of earth as time went on.

Such salt beds are common. Often many beds or veins lie one above the other, separated by layers of rock. In New York and Kansas there are solid salt beds over three hundred feet thick, and one at Sperenberg, Germany, is known to be over three thousand feet in thickness. The largest salt mine in the world is that at Wieliczka, in Poland. It is almost one thousand feet deep and extends three hundred feet below sea level. Over twenty-five miles of railroad are to be found in this mine, all meeting at a central station carved out of gleaming white salt which reflects the light.

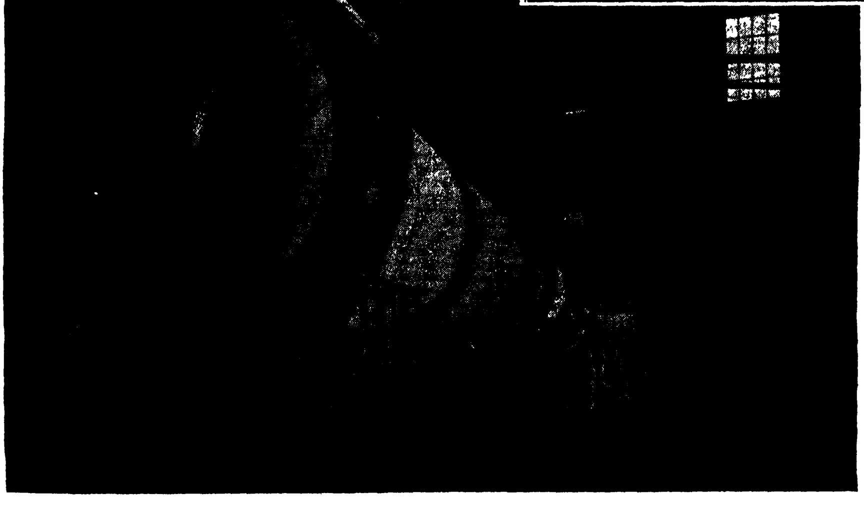
The largest salt mine in the Western Hemisphere is at Retsof, New York. Its miles and miles of underground passages cover an area almost as large as lower New York City. The thickest vein of salt yet discovered is at Avery Island, Louisiana. The oldest salt mine in the western world is here. Michigan, New York, Ohio, Kansas, Louisiana, Texas and California are the great salt-producing states. Salt is also taken from the Great Salt Lake, Utah. The United States produces around a quarter of the world's yearly consumption of salt. China, Germany, Great Britain, India and France are also important producers. Canada has some, mostly in Ontario.

When we think of all these great mines, we wonder where all the salt can go. Millions of tons a year are consumed as food. Other millions of tons are used for a vast variety of purposes, for salt plays an important part in industry, agriculture, chemistry and medicine, as well as in the homes of all of us.

There are two principal methods used today to obtain the tremendous quantities



The top of a vacuum pan is shown above. When the brine is "cooked" in this pan, the salt forms in crystals and falls to the salt catcher located below.



Photographs, courtesy, International Salt Co., Inc.

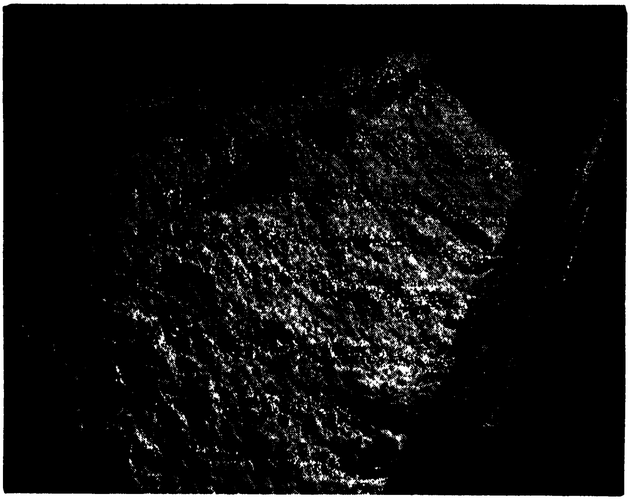
After filters have taken out some of the moisture, the salt is moved to these huge rotary dryers. The last trace of moisture is removed here.

of salt we consume. We have already spoken briefly of both methods. Let us examine them more closely. One is by the evaporation of salt brine, or a mixture of salt and water. The other is by mining rock salt from the underground beds or veins. This latter process is quite similar to that used in mining coal.

The salt brine used in the evaporation process is either surface brine coming from sea water or salt lakes, or brine from wells. Brine from wells may be natural or it may be made artificially by pumping water into wells drilled from the surface of the earth into the underground deposits of rock salt. Today large-scale salt-producing companies make use of two evaporating methods—the vacuum method and the grainer method. A third method, the Alberger process, is used in one of the large salt refineries in the United States

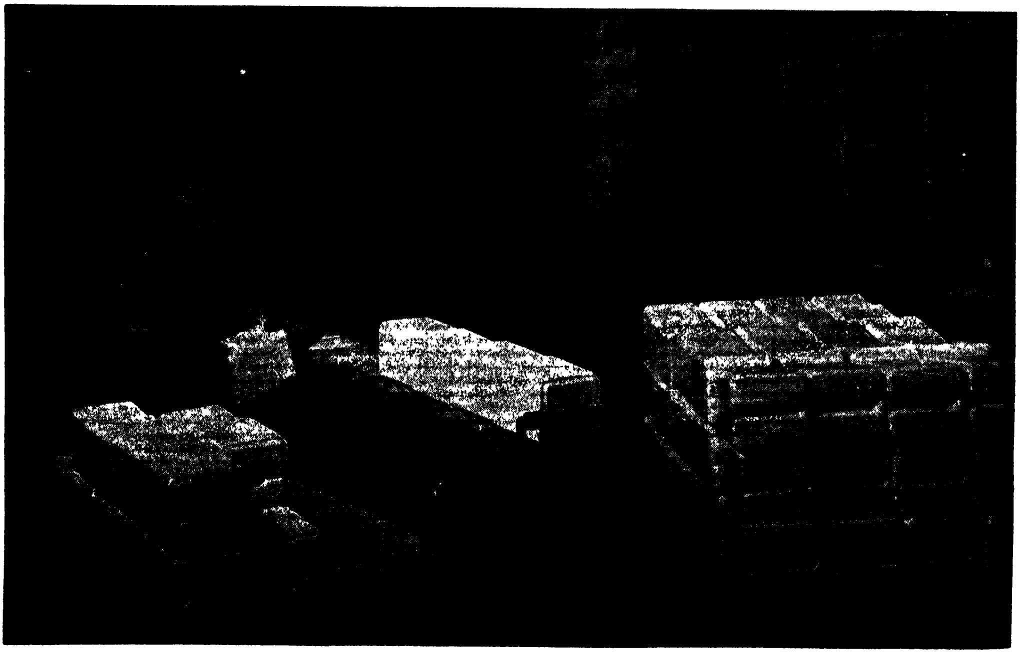
Salt produced by the vacuum-evaporation process is known as granulated salt, the most familiar form of which is table salt. There are many other important uses for granulated salt, however. Many branches of modern industry require a wide variety of types and grades of salt.

Vacuum-evaporated salt is produced in cast-iron vessels that are called vacuum pans.



Courtesy, International Salt Co., Inc.

In the grainer process, brine is heated in shallow, open pans. The heated water goes off in steam, and salt crystals form on top. They collect in groups, or flakes, and sink to the bottom.

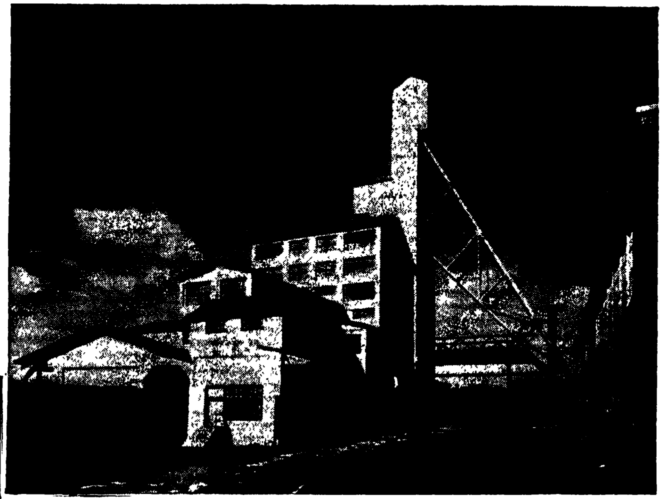


Courtesy, Diamond Crystal Salt Company

Salt compressed into block form is often used by farmers. They spread it in pastures for their animals to eat.

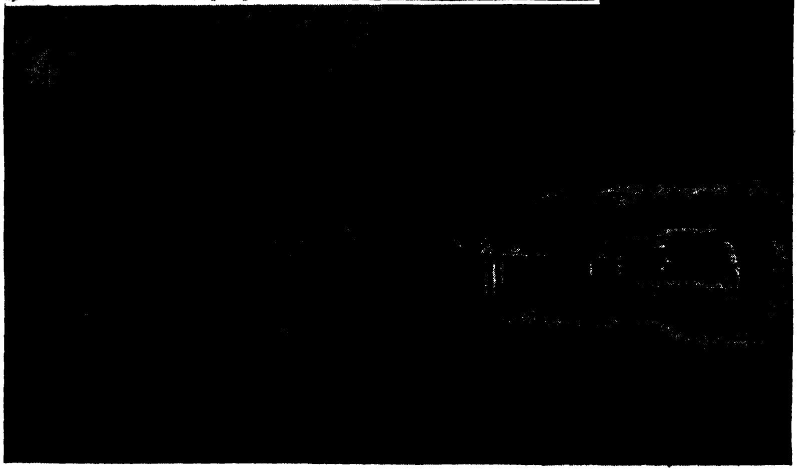
SALT, LIKE COAL, MAY COME FROM MINES

Millions of years ago the world's land surface, as we now know it, was largely covered with salt water. In drying, the seas left much salt behind in the earth; it is this salt that we mine today in almost the same way that we mine coal. The buildings at the right look very similar to those of a coal mine.

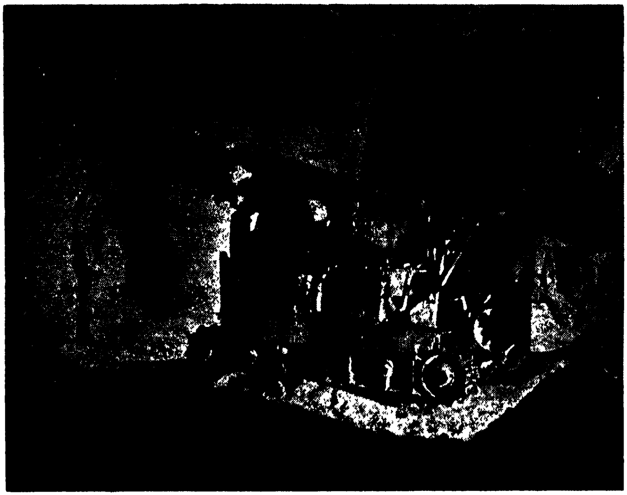


Photographs, courtesy,
International Salt Co., Inc.

Great quantities of salt are used in the packing and curing of meat, in curing hides, in tanning leather, and in the chemical and refrigeration industries.



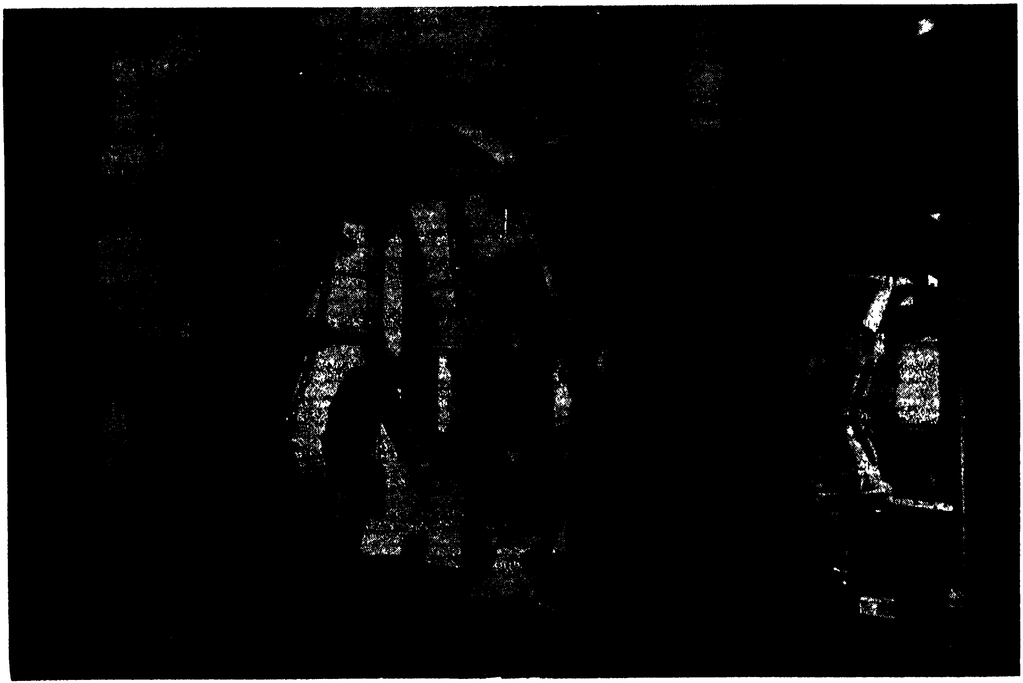
Powerful locomotives, run by electricity, haul long trains of salt from deep in the mine to the foot of a shaft that runs up to the ground level.



Deep cuts are made in the walls of salt, and then blasting powder is carefully placed so that upon explosion the salt tumbles down.

The brine is fed into these pans, heated by steam, and kept in motion to bring it in constant contact with the heating arrangement. When the brine begins to boil, salt crystals form and drop through the bottom of the vacuum pan into the salt catcher. They are removed from this catcher from time to time. The evaporation process carries on continually. From the vacuum pan the salt is pumped to filters which remove the excess moisture. The rotary dryers, to which the salt is next carried, give to the grains the dryness of the desert sands. After it leaves these rotary dryers the salt is conveyed to the automatic weighing and packaging machines.

Grainer salt, which is commonly known by the name of "flake salt," is produced by allowing brine to flow into tremendous pans, over one hundred feet in length, and between ten and twenty feet in width. It is then heated by means of steam. When the crystals of salt form, they float on the surface of the brine, for in the grainer process the brine is not agitated as it is in the vacuum-evaporation process. When still other crystals form, they gather on the first ones to form "hoppers" or flakes. As a

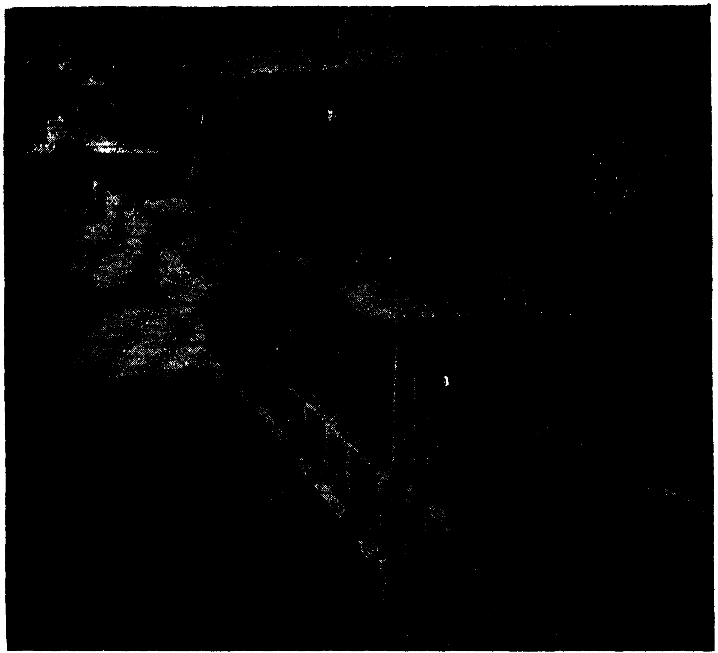


Photographs, courtesy, International Salt Co., Inc.

Cars, or skips, of salt are hoisted by electric cable from the bottom of the shaft to the very top of the breaker. They are overturned on screens which grade the lumps. Then the salt falls into the powerful crushers shown here. It is screened and crushed, screened again and crushed again, each time tumbling one step nearer the ground.

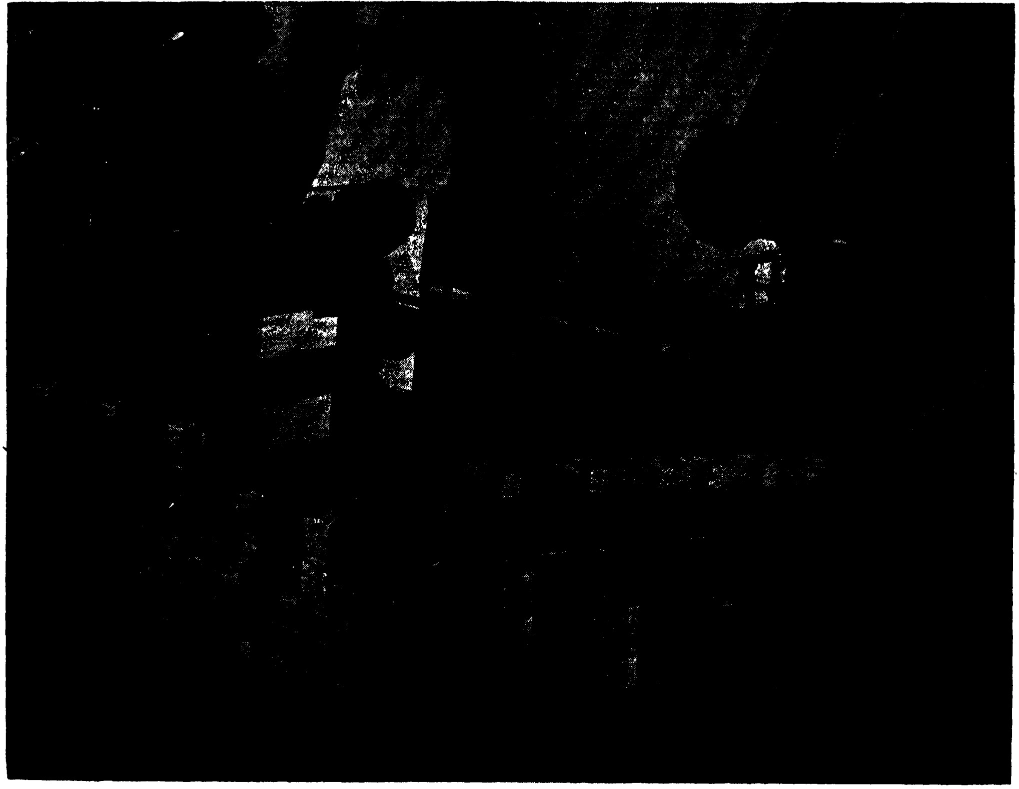
PACKING THE SALT FOR MARKET

After it has been refined, the salt may be packed in one-hundred-pound bags for shipment to distant places.



Photographs, courtesy,
International Salt Co., Inc.

Table salt comes to your home in a moisture-proof bag, can or carton. In the picture, machines are packing the cartons automatically.

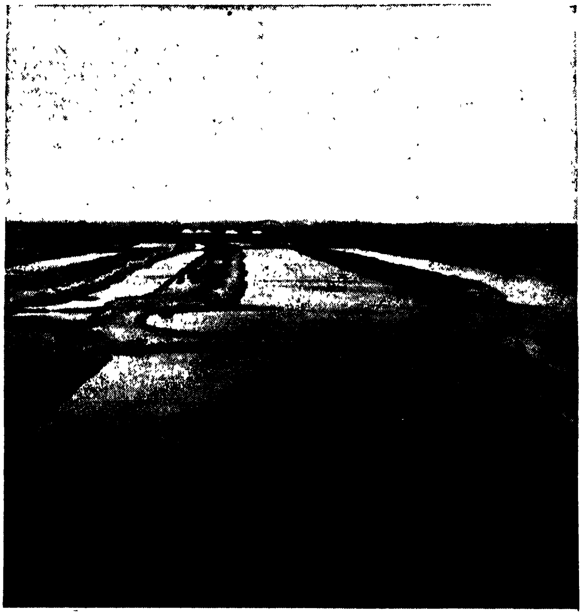


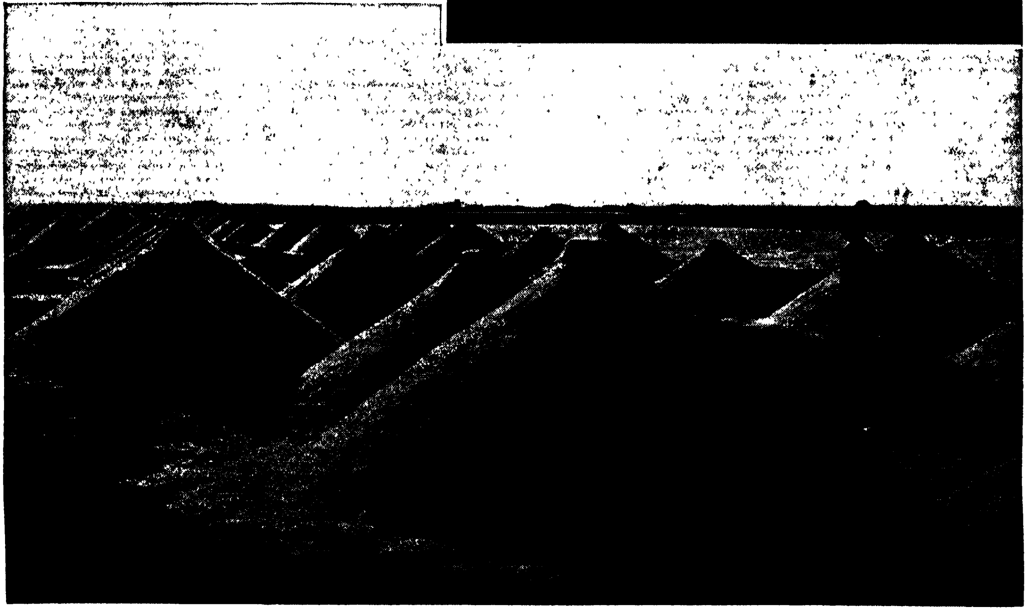
crystal, or flake, grows, it becomes heavier and sinks to the bottom of the grainer pan. The flakes are then removed and put through a drying and grading process. Grainer salt, a salt more coarsely grained than that formed in the vacuum pans, is widely used in the production of many food products, such as salted fish, cured meats and butter.

Mining rock salt is the other great process by which we obtain our salt supply. Rock salt also plays an important role in food industries. It is used as a refrigerant in making and storing such things as ice cream and in making ice itself. The chemical, paper and textile industries use great quantities of rock salt. It is also used as an economical way to melt ice, and we often see it spread on icy streets and pavements to prevent people and automobiles from slipping and skidding.

Men descend into the rock salt mine just as they do in a coal mine, the great difference being that the walls are white instead of being black. Machines cut into the salt and loosen it from the tunnel walls. Charges of dynamite break it free. Then the gleaming salt chunks are loaded into mine railroad cars and taken to giant crushers, where the large lumps are crushed to smaller sizes before the salt is carried to the surface. Above ground it is further crushed, screened and graded to the required commercial sizes. It is then packed in bags and is ready for shipment to the markets of the world.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5428.



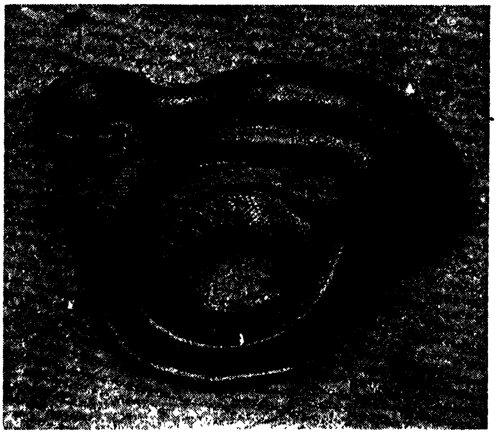


Underwood & Underwood; Philip D. Gendreau, N. Y.

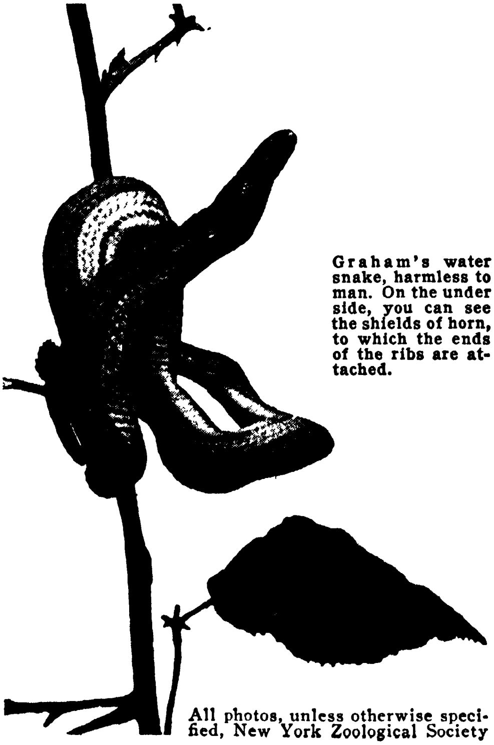
Salt is taken from the sea in many places. Shown here at the top are the salt basins of Cadiz, Spain, where salt is produced by allowing the sun to evaporate sea water. At the bottom, mounds of salt await shipment from India.

THE EXTRAORDINARY SNAKES

THERE are about seventeen hundred species of snakes distributed throughout the temperate and tropical regions of the world. They range in size from a tiny burrowing creature the size of a goose quill, and only a few inches long, to the great regal python, nearly or fully thirty feet long, and weighing three hundred pounds. Some species are poisonous, but more are harmless to man. Some lay eggs, but others bring forth their young alive. Some live on land, others spend most of their time in trees, while others are found in water, salt or fresh. Some are quick and graceful, others slow and awkward. Some are dull in appearance, while others flaunt bright colors.



The terrible anaconda of tropical South America, which kills by squeezing its prey to death.



Graham's water snake, harmless to man. On the under side, you can see the shields of horn, to which the ends of the ribs are attached.

All photos, unless otherwise specified, New York Zoological Society

Snakes generally produce many young. A great python may lay nearly a hundred eggs, though not all of them will hatch. Some of the snakes which bring forth their young alive may produce fifty or more at a birth, but the number is usually smaller. However, snakes have many foes, and their numbers are not increasing, certainly not in lands that are inhabited by man. There is an exception to this. In lands where religion or custom forbids killing animal life, as in parts of India, snakes may become a real plague.

Besides man, snakes have other enemies. Some birds are fond of them, and many animals, including the common pig, eat them. There are snakes which feed on other snakes. The king cobra will eat nothing else, and the king snake destroys many.

Naturalists tell us that the ancestors of the snakes in the long ago had four limbs. We can still see vestiges of limbs in certain of the boas. On the surface of the skin toward the rear part are a pair of claws; within are small bones, the whole forming the remains of a snake's departed hind legs.

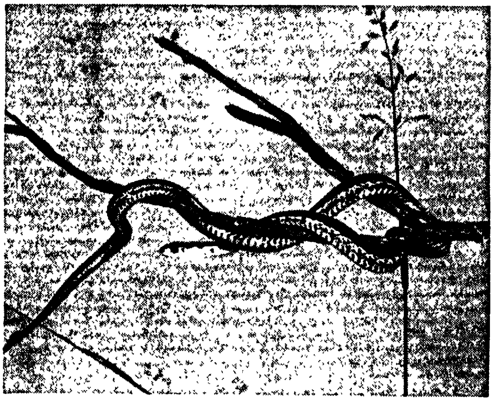
The snakes now have a different equipment, more suitable for gliding through narrow ways, climbing trees, swimming in river, lake and sea. They have an enormous number of ribs—sometimes three hundred pairs—loosely tied to the backbone. The free ends of the ribs are each attached to a shield of horn on the exterior of the skin beneath the body. It is by this plan that the snake moves. The ribs ripple forward, a pair at a time, and in doing so, thrust forward the rear edges of the shield to which they are united. At each movement the shield grips some rough spot on the ground, and so the whole body is drawn ahead.

The snakes that climb trees often have these under-shields placed in the form of a keel, and the arrangement enables them to glide rapidly up a tree. Some water snakes, not needing to make progress on land, have only small under-shields. But be it land or water to which they are committed, no snake can raise itself into the upright loops that pictures often suggest; the formation of the backbone prevents it. The wriggling movement of the reptiles is always horizontal. This one fact disposes of the tales of great sea serpents which are always supposed to appear at the surface of the sea exposing great coils arranged in upward and downward loops. Snakes are not built that way.

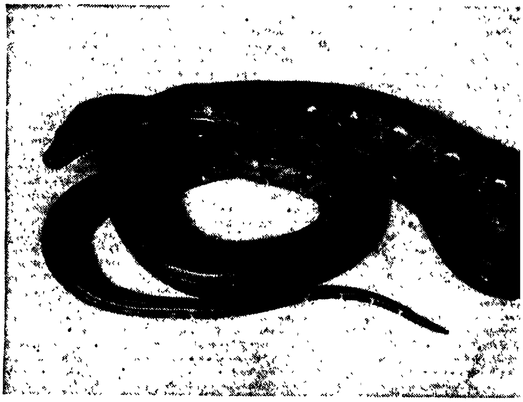
The food of snakes varies from eggs, insects, frogs, lizards and other snakes, to prey as great as human beings, large antelopes and goats. And the food is swallowed whole! Yet the head of a snake, through which such a meal must pass, is comparatively small. The fact is that the lower jaw is not solid bone like ours; it is in halves, united at the chin by elastic ligaments. When a victim is seized the snake draws itself over the body like a glove being made to envelop a hand. The lower jaw moves forward in steps, one half at a time. The throat and gullet of the reptile are incredibly flexible. A snake nine feet long has been known to swallow another of its kind only a few inches less in size.

The venom of poison snakes lies in very muscular sacs in each side of the upper jaw. In some species the sac extends past the forepart of the body. The teeth may be tubular, or they may be merely grooved. In either case there is a clear opening from the root of the tooth into the poison sac.

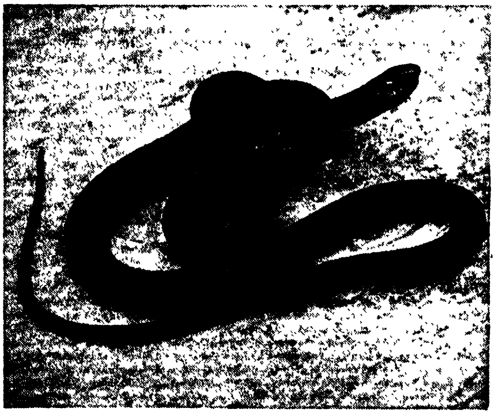
In many of the deadly serpents, when the mouth is closed, the poison fangs lie flat



A retiring dweller in the gardens of eastern North America—the striped, or garter, snake.



Power and great size combine in the regal, or reticulated, python, a fearsome snake of southern Asia.



The swift black snake, a racer, helpful to man.

Design in gray and black—the harmless milk snake.

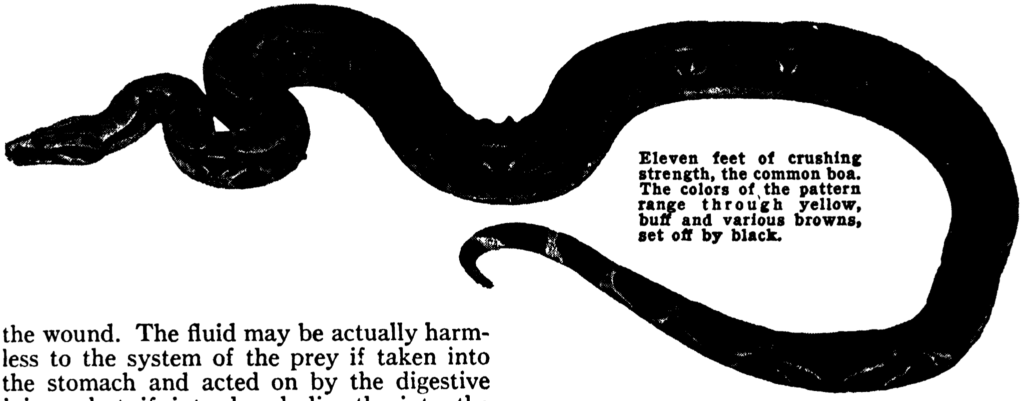
down in the jaw. When the mouth is opened to strike, the teeth rise into a perpendicular position, like the baleen in a whale's mouth.

The moment the fangs press on the flesh of a victim, venom is forced by muscular action from the sacs through the hollow root of the tooth, down the channel and into the wound. The fluid may be actually harmless to the system of the prey if taken into the stomach and acted on by the digestive juices; but if introduced directly into the blood, it rapidly causes trouble. The poison of some species paralyzes the nerve centers, stopping the heart and breathing, and causing swift and painful death. That of other species, such as our copperhead and rattlers, breaks down the blood capillaries, causing internal hemorrhages and discolored swellings near the wound.

Snakes live long and grow continuously; and in order that they may do so, they cast their skins several times a year. They have no eyelids; the eyes are fixed within transparent scales, which come away with the rest of the skin.

Excessive heat may cause some species to become torpid in summer; cold drives them into as deep a winter sleep as that of a hibernating bear. They can fast for months at a time, but they must drink if they are awake. Not even the sluggish snake can exist many months without moisture. Even the blind snakes drink—creatures of the underworld, sightless, toothless, harmless, living in burrows on ants and millipedes and the larvae of insects.

The big snakes all have keen sight and great teeth in both upper and lower jaws, and have fronted life with audacity since long before man, in the warmer parts of Asia, Africa, America, Australia and the West Indies. India and Malacca have a python thirty feet long, and the great anaconda, or water boa, of tropical America may reach nearly the same size.



Eleven feet of crushing strength, the common boa. The colors of the pattern range through yellow, buff and various browns, set off by black.

No wonder these reptiles can crush deer, sheep and men. Appetites are naturally keener in the wilds than in a cage at a zoo; but in a zoo a boa 14 feet long has been known to eat 4 dead lambs, each between 12 and 19 pounds in weight, and each having horns several inches long. That was a meal consumed within twenty-four hours, and sufficed for only ten days, when a fifth lamb was eaten. Another boa is said to have swallowed a goat weighing 93 pounds in an hour and a half; while a third, after eating a 31-pound goat, swallowed a 43-pound deer the same day.

The crushing of the prey is caused not merely by the swallowing. When the animal is seized, the snake holds its victim's head with its fangs, wraps its great coils round and round the body, and squeezes with terrific force. Pressure is continued as long as any movement indicates that the prey is still alive.

In common speech all large snakes are sometimes called boa constrictors. It is true that all the big snakes are constrictors and kill their prey by squeezing it; but the pythons and the boas are separate subfamilies, and the name boa constrictor properly belongs to only one of the boas, and that not the largest. This is the common boa of South America.

The pythons number many species, and Australasia and the East have some notable examples. The largest is the regal, or reticulated, python of southern Asia and the neighboring islands. The Indian, or black-tailed, python is smaller and can be tamed. This species is frequently shown by snake charmers. Not all the pythons are large. Some are not more than six or eight feet long when full grown. Except one small species found in Mexico, all belong to the Old World. With varying size we find varying habit. Some are haunters of rocks, some take to trees.

Boas are found in both hemispheres. Though some are small, the gigantic anaconda of South America is a fearsome reptile. It swims superbly and spends much of its time on half-submerged logs. It may rest among the branches of a huge tree and reach down to pick up an unsuspecting peccary or a deer from the ground below. The yellow anaconda is somewhat smaller.

Though not poisonous, the anaconda is one of the most terrible of living things; to it all animal life is simply a meal for the getting. A friend of the writer was attacked in a boat by one of these and lived to tell the tale as the most horrifying adventure in a career of many perils.

There are many other boas. The common boa *(Constrictor constrictor)* is seldom over eleven feet long. The Cuban boa is about the same size and is a particularly clever chicken thief. The rainbow boa shows gorgeous greens and violets in the sunlight. Then there are several species of tree boas which have long slender bodies and large heads. They spend nearly all their time in trees and are always bad-tempered.

The sand boas of Africa and Asia are generally short, clumsy snakes which get their living by burrowing in the ground. They eat small mammals. In America a close ally is the rubber boa, which may be found as far north as Oregon.

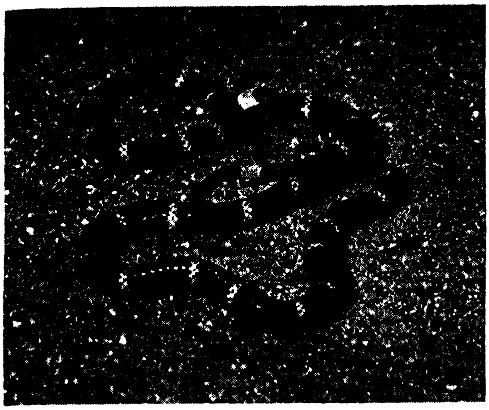
The most common American snakes are the striped, or garter, snakes, of which there are many species, and in a species the color often varies. Since a female may give birth to as many as seventy-five little ones, it is no wonder that they are common. They live upon earthworms, small fish, tadpoles, frogs and toads, and seldom are more than three feet long. The common garter snake of our gardens is entirely harmless and should never be killed.

THE SWIFTLY GLIDING RACERS, FOUND IN BOTH OLD AND NEW WORLDS

Next we may mention the racers, found in both hemispheres. The American black snake is found from the Atlantic to the Pacific. It is graceful and swift, and is not only harmless to man, but does much good by eating rats and mice and the young of other snakes, though it does not object to young birds. Closely allied are the coachwhip and the gopher snakes. Their habits and their food are much the same.

The pilot snake is believed by the superstitious to warn the rattlesnake of the approach of danger. It is harmless, and so is the chicken snake, which eats many more

Two of the most venomous serpents on earth: Left, head of the huge king cobra Above, an excited cobra de capello, its neck expanded into a broad hood.



The coral snake, vividly banded in red, black and yellow, one of the most evil in the New World.

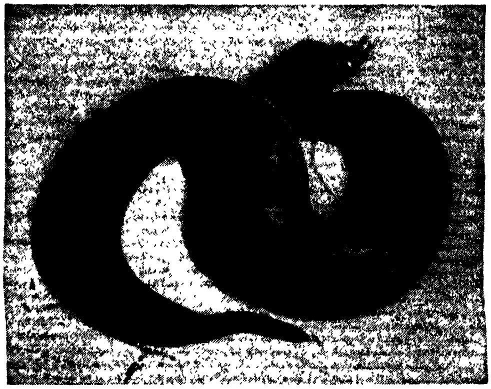
A yellow sea snake, fairly small but poisonous. It is deadly to fish and other marine life.

rats and mice than chickens. The hog-nosed snake is hideously ugly and is often called the puff adder, but it, too, is harmless, and lives on frogs and toads. The king snake is a handsome cannibal that attacks any other snake it meets, no matter if poisonous. If bitten by its prey, it seems to suffer little harm. It is gentle toward man and makes an interesting pet. The stories that the milk snake steals milk from cows are fables.

ARCHVILLAINS OF THE SNAKES, THE VICIOUS COBRAS

So far we have not described any of the poisonous snakes. Now we come to the cobras, with their striking hoods. There are ten species in all, confined to Africa and southern Asia with the adjacent islands. A typical cobra is about six feet long, and it is the deadliest six feet in the world. The spectacled cobra, or cobra de capello, of India is the most vicious of all snakes. The king cobra, or hamadryas, is twelve feet or more and not wholly evil, for it gorges on other snakes as it can catch them. The Egyptian cobra, or asp, is smaller but equally deadly. The cobras are all dangerous, capable of killing a man in half an hour if their poison is introduced into a blood vessel. Australia's death adder is a villain in the same tragic cast.

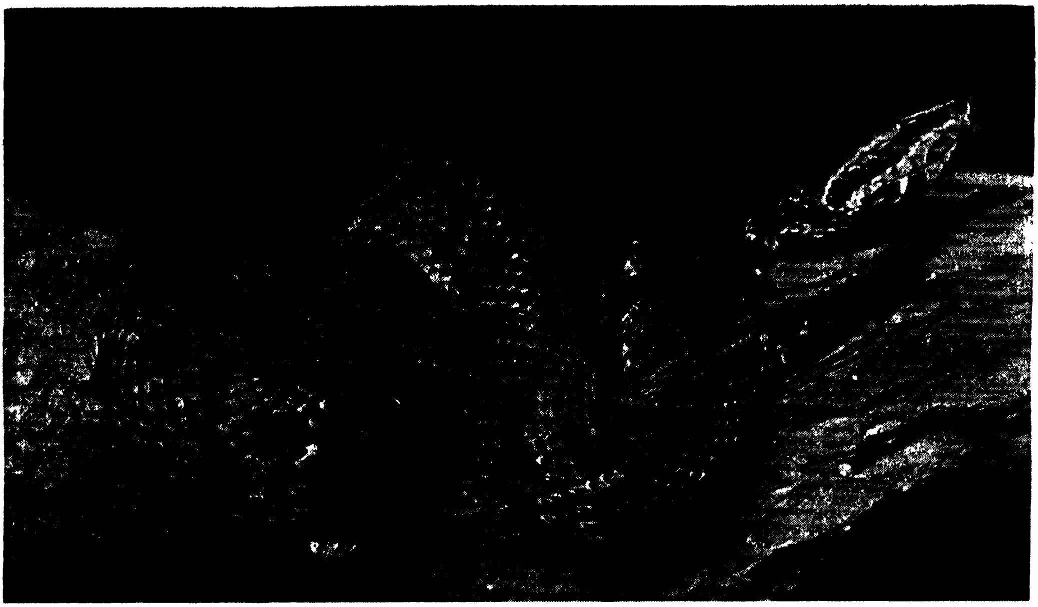
It is bad enough to be poisoned by contact, but an African cobra, the ringhals, can injure at a distance. It has the power of squirting out venom and striking an object several feet away. This can not kill, but the fluid is said to cause temporary injury to the eyes, and the reptiles have a gift of marvelous accuracy in reaching the eye of a man or an animal at which they aim.



Raymond L. Ditmars
The rhinoceros viper, scaly, ugly and venomous.

Closely allied to the cobras is a group of snakes of which the deadly krait of southern Asia is a representative. The nearest relatives of these snakes in the New World are the coral snakes, of which two species are found in the United States and the other twenty-four in Mexico, Central and South America. They are generally marked with red, black and yellow, and closely resemble some harmless species.

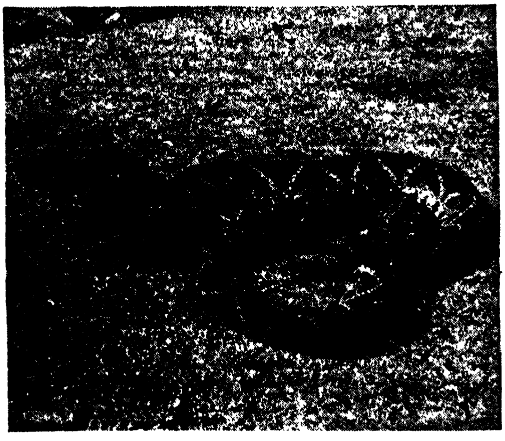
We come to the sea snakes. Of the great sea serpents, the last is believed to have died many, many years ago, but there are comparatively small sea snakes that can kill a man swimming in the sea and are deadly to fish and other marine life. The virulence of their poison varies with the species, but it has been found that some species have a poison as deadly as that of some cobras.



Hideous and a lurking peril in the swamps of the southern United States—the water moccasin, or cottonmouth. It feeds principally on fish and other small water animals, but will prey on anything it can get.

Like the water snakes, the vipers, with one or two exceptions, produce their young alive. They may be divided into two groups: the true vipers, which are confined to the Old World; and the pit vipers, so called because they have a deep pit between the eye and the nostril on each side of the head. The pit vipers include our more important venomous snakes, though some species live in the Old World.

There are ten species of the true vipers. The common viper of Europe is the only venomous snake in the British Isles, where it is often called an adder. Its bite causes illness, but seldom death. Other species are: the Cape viper of South Africa; the tic polonga, or Russell's viper, one of the most deadly serpents of India; the puff adder of Africa and Arabia; the rhinoceros viper, the horned viper and, the ugliest of all, the Gabun viper of Africa. Some think that the horned viper, not the asp, is the snake that caused the death of Cleopatra.



Greenish gray in color, the dreaded fer-de-lance hides in the forests of tropical America.

There are about seventy species of pit vipers. The purpose or the use of these pits we do not know, but the bone is hollowed out on each side of the head, and a large nerve leads to the pit; and its presence is a warning to us to let the snake that possesses it severely alone.

First we may mention the water moccasin, or cottonmouth, of the South. This snake may grow to be six feet long, and is one of the deadliest as well as the ugliest of American snakes. It eats fishes, frogs, other snakes, small animals—anything it can get. There is a smaller species in Mexico and Central America. Closely akin is the copperhead, a smaller upland snake, sometimes called the highland moccasin. Its reddish brown color gives the name. It is found from New England southward east of the Mississippi, and also in Texas.

The next group includes two of the deadliest of New World serpents. The bushmaster of Central and South America may reach a length of twelve feet, but is rather slender. It is reddish yellow in color, with black bands. It lays eggs instead of bringing forth young alive. The deadly fer-de-lance (lance-head) of Central and South America and the West Indies is greenish gray in color, with dark bands, and is hardly more than six feet long. The palm viper is sometimes brought to the North in cargoes of bananas.

The rattlesnakes are divided into two genera and from eighteen to twenty species. One species is found in South America, but most of them make their home in Mexico and the southern United States. A few species are found as far north as southern Canada. Though they differ much in size and color, they are all distinguished by the "rattle."

When born, the baby rattler has no rattle, but merely a "button." Each time the skin is shed the top of the old skin remains attached to the end of the tail. It is the rustling of one of these tips over the adjacent one that makes the characteristic sound. There is a popular belief that each rattle represents a year of age. This is not true. The rattlesnake may shed its skin oftener than once a year, and, on the other hand, some of the rattles may be broken and lost.

The timber, or banded, rattlesnake, found in the rocky hills of eastern North America.

The largest and most venomous of the rattlers is the diamondback of southeastern United States. It grows to be eight feet long, and is the heaviest of poisonous serpents. The Texas, or western diamond, rattlesnake ranges from Texas to California. It is paler than the eastern species, and not quite so large. Another snake of the arid regions is the horned rattlesnake, or sidewinder, so called from its motion. It has a horn above each eye, and is yellowish or pinkish with darker markings. It is seldom more than three feet long. The common rattlesnake of the East is the timber, or banded, rattlesnake. It may be entirely black or yellow and black. It prefers rocky hills and ledges, and in some regions is quite common. In winter, dozens, or even hundreds sometimes gather in crevices in the rocks and pass the winter days in company. When warm days come they crawl out of their winter homes to bask in the sun.

The Pacific rattlesnake is found in the West from British Columbia south to Utah. It is yellowish brown and black, and is rarely much over three feet long. Occasionally black specimens are found. The prairie rattlesnake is found in the plains region. It is about the same size and color as the Pacific species.

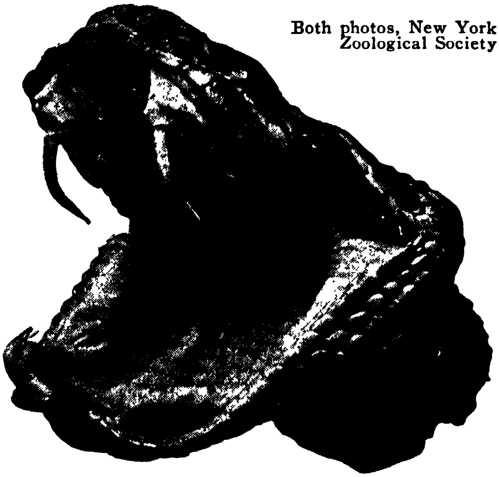
Other rattlesnakes are the pigmy rattlesnake of southeastern United States, gray in color, marked with black on the back. It is not more than eighteen or twenty inches long, and the rattle is correspondingly small; but it is a true rattlesnake, though its bite is seldom fatal. A larger species, the massasauga, is found in the center of the continent. The South American rattlesnake is also found in Mexico and Central America.

We have now finished our survey of the snakes. It is well to remember that we have but four poisonous snakes in North America. These are the rattlesnake and the copperhead in the North, and in addition to these the South has the coral snake and the water moccasin.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5454.

A detested inhabitant of the Middle West—the massasauga, a medium-sized rattlesnake.

What Makes the Poison in a Snake's Fang?

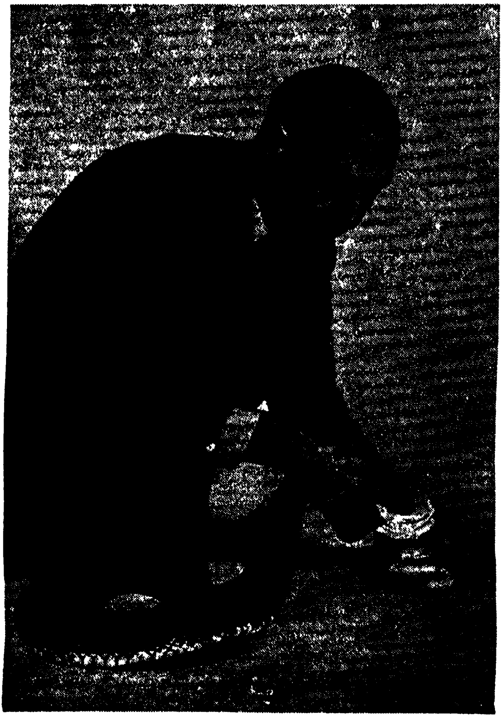


Both photos, New York Zoological Society

Head of a diamondback rattlesnake, showing the curved fangs through which the poison runs from glands.

A SNAKE'S fang is an eye tooth, or canine tooth, corresponding to the sharp-pointed teeth that we have at the corners of the jaw between the front teeth and the back teeth. In the poisonous snakes the tooth has a special channel through which the poison can run when the snake bites. The snake has certain glands corresponding to those we have in front of the ear, the ones that get so big and painful when we have mumps. In the snake the business of these glands is to produce the poison. It runs along a little tube from the glands on each side of the mouth to the poison teeth. When the snake bites, the muscles of the jaw, which make the teeth meet, also squeeze upon the glands and upon these tubes in such a way that a little of the poison is forced through the channel in the fang, and left in the victim's body.

The amount of poison thus injected is, as a rule, exceedingly tiny, but the venom, or poison, of many of the venomous snakes is among the most deadly of all poisons. A mere portion of a drop will kill. Thus you see that, in certain animals, parts of the body that are possessed by many other kinds of animals, and that serve one purpose, are turned to quite a new and special purpose. In non-poisonous snakes, these glands look just the same, yet produce nothing to hurt anyone.



"Milking" a rattler to get samples of its venom.

CAN POISONOUS SNAKES BITE WITHOUT POISONING?

Some can and some can not. The way that poisonous snakes use their fangs to inject poison is one of the most wonderful things in nature, and in the case of some of them—for instance, the common adder or viper, which lives all over Europe—this poison fang and its venom are used only as a means of self-defense.

But the adder, as a rule, does not use its poison fang when it bites the animal on which it feeds, and so it has a very curious arrangement by means of which these fangs are laid flat back in the roof of the mouth out of the way of the ordinary teeth that are used for feeding. Thus, the adder can use its fangs when it wishes to kill its foe, and it can tuck them securely out of the way and use its ordinary teeth at mealtime. In some of the other poisonous snakes the fangs are fixed and can not be used in this way.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5438.

Poetry of the Eighteenth Century: Part II

Illustrated by William Sharp

From The Deserted Village

By Oliver Goldsmith (1728-1774)

Sweet Auburn! loveliest village of the plain,
Where health and plenty cheered the laboring swain,
Where smiling spring its earliest visit paid,
And parting summer's lingering blooms delayed:
Dear lovely bowers of innocence and ease,
Seats of my youth, when every sport could please:
How often have I loitered o'er thy green,
Where humble happiness endeared each scene!
How often have I paused on every charm,
The sheltered cot, the cultivated farm,
The never-failing brook, the busy mill,
The decent church that topped the neighboring hill,
The hawthorn bush, with seats beneath the shade,
For talking age and whispering lovers made!
How often have I blessed the coming day,
When toil remitting lent its turn to play,
And all the village train, from labor free,
Led up their sports beneath the spreading tree:
While many a pastime circled in the shade,
The young contending as the old surveyed;
And many a gambol frolicked o'er the ground,
And sleights of art and feats of strength went round:
And still, as each repeated pleasure tired,
Succeeding sports the mirthful band inspired;
The dancing pair that simply sought renown,
By holding out, to tire each other down;
The swain mistrustless of his smutted face,
While secret laughter tittered round the place;
The bashful virgin's sidelong looks of love,
The matron's glance that would those looks reprove,—
These were thy charms, sweet village! sports like these,
With sweet succession, taught e'en toil to please;
These round thy bowers their cheerful influence shed,
These were thy charms,—but all these charms are fled.

Sweet smiling village, loveliest of the lawn,
Thy sports are fled, and all thy charms withdrawn;
Amidst thy bowers the tyrant's hand is seen,
And desolation saddens all thy green;
One only master grasps the whole domain,
And half a tillage stints thy smiling plain;
No more thy glassy brook reflects the day,
But, choked with sedges, works its weedy way;
Along thy glades, a solitary guest,
The hollow-sounding bittern guards its nest;
Amidst thy desert walks the lapwing flies,
And tires their echoes with unvaried cries.
Sunk are thy bowers in shapeless ruin all,
And the long grass o'ertops the moldering wall,
And, trembling, shrinking from the spoiler's hand,
Far, far away thy children leave the land.

Ill fares the land, to hastening ills a prey,
Where wealth accumulates, and men decay:
Princes and lords may flourish, or may fade;
A breath can make them, as a breath has made;
But a bold peasantry, their country's pride,
When once destroyed, can never be supplied.

A time there was, ere England's griefs began,
When every rood of ground maintained its man;
For him light labor spread her wholesome store,
Just gave what life required, but gave no more:
His best companions, innocence and health;
And his best riches, ignorance of wealth.

But times are altered: trade's unfeeling train
Usurp the land and dispossess the swain;

Along the lawn, where scattered hamlets rose,
Unwieldy wealth and cumbrous pomp repose,
And every want to opulence allied,
And every pang that folly pays to pride.
Those gentle hours that plenty bade to bloom,
Those calm desires that asked but little room,
Those healthful sports that graced the peaceful scene,
Lived in each look, and brightened all the green,—
These, far departing, seek a kinder shore,
And rural mirth and manners are no more.

Lochinvar

From MARMION

By SIR WALTER SCOTT (1771-1832)

O, YOUNG Lochinvar is come out of the west,
Through all the wide Border his steed was the best;
And, save his good broadsword, he weapon had none,
He rode all unarmed, and he rode all alone.
So faithful in love, and so dauntless in war,
There never was knight like the young Lochinvar.

He stayed not for brake, and he stopped not for stone,
He swam the Eske River where ford there was none;
But, ere he alighted at Netherby gate,
The bride had consented, the gallant came late;
For a laggard in love, and a dastard in war,
Was to wed the fair Ellen of brave Lochinvar.

So boldly he entered the Netherby Hall,
Among bridesmen, and kinsmen, and brothers, and all.
Then spoke the bride's father, his hand on his sword,
(For the poor craven bridegroom said never a word),
"O come ye in peace here, or come ye in war,
Or to dance at our bridal, young Lord Lochinvar?"

"I long wooed your daughter, my suit you denied;—
Love swells like the Solway, but ebbs like its tide,—
And now am I come, with this lost love of mine,
To lead but one measure, drink one cup of wine.
There are maidens in Scotland more lovely by far,
That would gladly be bride to the young Lochinvar."

The bride kissed the goblet; the knight took it up,
He quaffed off the wine, and he threw down the cup:
She looked down to blush, and she looked up to sigh,
With a smile on her lips, and a tear in her eye.

He took her soft hand, ere her mother could bar,—
"Now tread we a measure!" said young Lochinvar.

So stately his form, and so lovely her face,
That never a hall such a galliard did grace;
While her mother did fret, and her father did fume,
And the bridegroom stood dangling his bonnet and plume;
And the bride-maidens whispered, " 'Twere better by far,
To have matched our fair cousin with young Lochinvar."

One touch to her hand, and one word in her ear,
When they reached the hall-door, and the charger stood near:
So light to the croupe the fair lady he swung,
So light to the saddle before her he sprung!
"She is won! we are gone! over bank, bush and scaur,
They'll have fleet steeds that follow," quoth young Lochinvar.

There was mounting 'mong Graemes of the Netherby clan;
Fosters, Fenwicks, and Musgraves, they rode and they ran:
There was racing and chasing on Cannobie Lee,
But the lost bride of Netherby ne'er did they see.
So daring in love, and so dauntless in war,
Have ye e'er heard of gallant like young Lochinvar?

The Minstrel's Song

From AELLA

By THOMAS CHATTERTON (1752-1770)

Oh sing unto my roundelay;
Oh drop the briny tear with me;
Dance no more at holiday;
Like a running river be!
My love is dead,
Gone to his death-bed,
All under the willow-tree!

Black his hair as the winter night,
White his throat as the summer snow,
Red his cheek as the morning light,
Cold he lies in the grave below.

Sweet his tongue as the throstle's note;
Quick in dance as thought can be;
Deft his tabor, cudgel stout,
Oh, he lies by the willow tree.

Hark! the raven flaps his wing
In the briery dell below;
Hark! the death-owl loud doth sing,
To the night-mares as they go.

See! the white moon shines on high;
Whiter is my true love's shroud;
Whiter than the morning sky,
Whiter than the evening cloud.

Here, upon my true love's grave,
Shall the barren flowers be laid;
Not one holy saint to save
All the coldness of a maid.

With my hands I'll twist the briers
Round his holy corpse to gre;
Elfin fairy, light your fires,
Here my body still shall be.

Come, with acorn-cup and thorn,
Drain my heartès blood away;
Life and all its good I scorn,
Dance by night, or feast by day.

Water-witches, crowned with reeds,
Bear me to your deadly tide.
I die! I come! my true love waits!—
Thus the damsel spake, and died.

Hunting Song

From THE LAY OF THE LAST MINSTREL

By SIR WALTER SCOTT (1771-1832)

Waken, lords and ladies gay,
On the mountain dawns the day,
All the jolly chase is here,
With hawk and horse and hunting-spear!
Hounds are in their couples yelling,
Hawks are whistling, horns are knelling,
Merrily, merrily, mingle they,
"Waken, lords and ladies gay."

Waken, lords and ladies gay,
The mist has left the mountain gray,
Springlets in the dawn are steaming,
Diamonds on the brake are gleaming:
And foresters have busy been
To track the buck in thicket green;
Now we come to chant our lay,
"Waken, lords and ladies gay."

Waken, lords and ladies gay,
To the green-wood haste away;
We can show you where he lies,
Fleet of foot and tall of size;
We can show the marks he made,
When 'gainst the oak his antlers frayed;
You shall see him brought to bay,
"Waken, lords and ladies gay."

Louder, louder chant the lay,
Waken, lords and ladies gay!
Tell them youth and mirth and glee
Run a course as well as we;
Time, stern huntsman, who can balk,
Staunch as hound and fleet as hawk?
Think of this and rise with day,
Gentle lords and ladies gay.

My Heart's in the Highlands

By Robert Burns
(1759-1796)

Farewell to the Highlands, farewell to
the North,
The birthplace of valor, the country of
worth!
Wherever I wander, wherever I rove,
The hills of the Highlands for ever I love.

My heart's in the Highlands, my heart is
not here,
My heart's in the Highlands a-chasing the
deer,
A-chasing the wild deer and following the
roe—
My heart's in the Highlands, wherever
I go.

Farewell to the mountains high-covered
with snow,
Farewell to the straths and green valleys
below,
Farewell to the forests and wild-hanging
woods,
Farewell to the torrents and loud-pouring
floods!

My heart's in the Highlands, my heart is
not here;
My heart's in the Highlands a-chasing the
deer,
A-chasing the wild deer and following the
roe—
My heart's in the Highlands, wherever
I go.

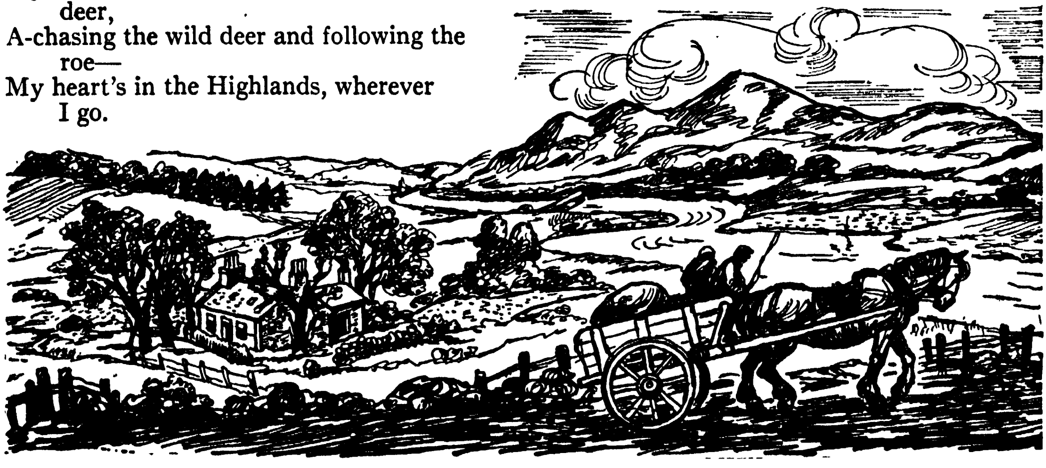
Cavalier's Song

By Robert Cunningham-Graham

If doughty deeds my lady please,
Right soon I'll mount my steed;
And strong his arm and fast his seat,
That bears frae me the meed.
I'll wear thy colors in my cap,
Thy picture in my heart;
And he that bends not to thine eye
Shall rue it to his smart!
Then tell me how to woo thee, Love;
O tell me how to woo thee!
For thy dear sake nae care I'll take,
Though ne'er another trow me.

If gay attire delight thine eye
I'll dight me in array;
I'll tend thy chamber door all night,
And squire thee all the day.
If sweetest sounds can win thine ear,
These sounds I'll strive to catch;
Thy voice I'll steal to woo thysel',
That voice that nane can match.
Then tell me how to woo thee, Love;
O tell me how to woo thee!
For thy dear sake nae care I'll take
Though ne'er another trow me.

But if fond love thy heart can gain,
I never broke a vow;
Nae maiden lays her skaith to me,
I never loved but you.
For you alone I ride the ring,
For you I wear the blue;
For you alone I strive to sing,
O tell me how to woo!
Then tell me how to woo thee, Love;
O tell me how to woo thee!
For thy dear sake nae care I'll take
Though ne'er another trow me.



The Old Familiar Faces

By CHARLES LAMB (1775-1834)

I HAVE had playmates, I have had companions,
In my days of childhood, in my joyful school-days—
All, all are gone, the old familiar faces.

I have been laughing, I have been carousing,
Drinking late, sitting late, with my bosom cronies—
All, all are gone, the old familiar faces.

I loved a Love once, fairest among women:
Closed are her doors on me, I must not see her—
All, all are gone, the old familiar faces.

I have a friend, a kinder friend has no man:
Like an ingrate, I left my friend abruptly;
Left him, to muse on the old familiar faces.

Ghost-like I paced round the haunts of my childhood,
Earth seemed a desert I was bound to traverse,
Seeking to find the old familiar faces.

Friend of my bosom, thou more than a brother,
Why wert not thou born in my father's dwelling?
So might we talk of the old familiar faces—

How some they have died, and some they have left me,
And some are taken from me; all are departed—
All, all are gone, the old familiar faces.

Flow Gently, Sweet Afton

By ROBERT BURNS (1759-1796)

FLOW gently, sweet Afton, among thy green braes!
Flow gently, I'll sing thee a song in thy praise!
My Mary's asleep by thy murmuring stream—
Flow gently, sweet Afton, disturb not her dream!

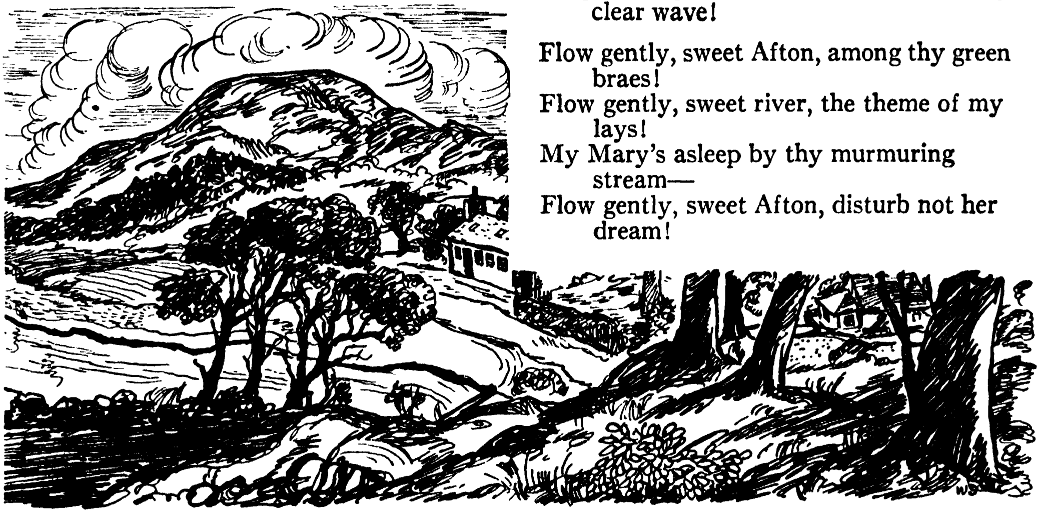
Thou stock dove whose echo resounds through the glen,
Ye wild whistling blackbirds in yon thorny den,
Thou green-crested lapwing, thy screaming forbear—
I charge you, disturb not my slumbering fair!

How lofty, sweet Afton, thy neighboring hills,
Far marked with the courses of clear winding rills!
There daily I wander, as noon rises high,
My flocks and my Mary's sweet cot in my eye.

How pleasant thy banks and green valleys below,
Where wild in the woodlands the primroses blow;
There oft, as mild Evening weeps over the lea,
The sweet-scented birk shades my Mary and me.

Thy crystal stream, Afton, how lovely it glides,
And winds by the cot where my Mary resides!
How wanton thy waters her snowy feet lave,
As, gathering sweet flowerets, she stems thy clear wave!

Flow gently, sweet Afton, among thy green braes!
Flow gently, sweet river, the theme of my lays!
My Mary's asleep by thy murmuring stream—
Flow gently, sweet Afton, disturb not her dream!



The Piper

By WILLIAM BLAKE (1757-1827)

PIPING down the valleys wild,
  Piping songs of pleasant glee,
On a cloud I saw a child,
  And he laughing said to me:

"Pipe a song about a Lamb!"
  So I piped with merry cheer.
"Piper, pipe that song again";
  So I piped: he wept to hear.

"Drop thy pipe, thy happy pipe;
  Sing thy songs of happy cheer":
So I sang the same again,
  While he wept with joy to hear.

"Piper, sit thee down and write
  In a book, that all may read."
So he vanished from my sight,
  And I plucked a hollow reed,

And I made a rural pen,
  And I stained the water clear,
And I wrote my happy songs
  Every child may joy to hear.

THE NEXT POEMS ARE ON PAGE 5521.

Coronach

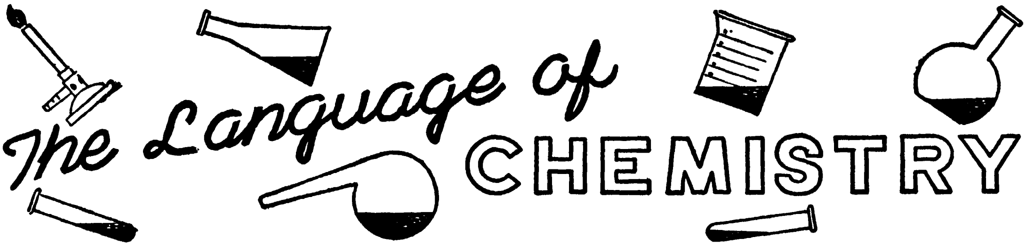
From THE LADY OF THE LAKE

By SIR WALTER SCOTT (1771-1832)

HE is gone on the mountain,
  He is lost to the forest,
Like a summer-dried fountain,
  When our need was the sorest.
The font, reappearing
  From the raindrops shall borrow,
But to us comes no cheering,
  To Duncan no morrow!

The hand of the reaper
  Takes the ears that are hoary,
But the voice of the weeper
  Wails manhood in glory.
The autumn winds rushing
  Waft the leaves that are serest.
But our flower was in flushing,
  When blighting was nearest.

Fleet foot on the correi,
  Sage counsel in cumber,
Red hand in the foray,
  How sound is thy slumber!
Like the dew on the mountain,
  Like the foam on the river,
Like the bubble on the fountain,
  Thou art gone, and for ever!



The Language of CHEMISTRY

HOW CHEMISTS IN MANY LANDS UNDERSTAND EACH OTHER

ALL through science—as in many another branch of learning and in our everyday life—you will find that we can say more in less time, put more meaning into what we say and express that meaning more clearly and more precisely if we use symbols, abbreviations and numbers instead of only words. You are familiar with the expression C.O.D. and the statement printed on the outside label of a No. 2½ can of peaches: contents 1 lb. 14 oz. Those are symbols.

The chemist uses symbols, for one thing, to indicate chemical elements. The symbol for most elements is the first letter of the Latin name of the element; but if there is more than one element whose name begins with the same letter we need to add a second letter to it.

The letter H stands for hydrogen; He stands for helium. C is carbon; Ca means calcium; Cl is chlorine; Co is cobalt; and Cu is copper. Iron is called *ferrum* in Latin, so we use the symbol Fe; F alone stands for fluorine. Silver and gold are *argentum* and *aurum* in Latin, so we indicate them by Ag and Au. The lone A is the gas argon; and Al is aluminum. P stands for phosphorus; Pb for lead (*plumbum* in Latin); and Pt is platinum. Mercury is *hydrargyrum* in Latin, so we use Hg for it in chemistry. Magnesium is Mg; and manganese is Mn. N is nitrogen; Ni is nickel. Sulfur is S; but silicon is Si; and tin (in Latin *stannum*) is Sn.

There are some exceptions. Sodium and potassium, which were not known in ancient times, are also called *natrium* and *kalium*, and their symbols are Na and K. The metal we call tungsten is also called *wolframium* after its discoverer and has the symbol W.

This is a quick and simple way of representing chemical elements; and we use these same letters to represent the atoms themselves. H not only means hydrogen gas; it is also used to indicate one atom of hydrogen. By joining the letters for the different atoms together we can then use such a combination of letters to indicate a compound of the atoms involved. In this way Na means one atom of sodium; Cl, one atom of chlorine; and NaCl is a combination of one atom of each—in other words, one molecule of ordinary salt. CaO represents one molecule of quicklime, containing one atom each of calcium and oxygen.

It is easy by this method, too, to indicate the valence of an atom, that is, the number of "hooks" it has to attach itself to others. One molecule of water is made up of two atoms of hydrogen of valence one, and one atom of oxygen of valence two; so we write it H_2O. Calcium is divalent (two hooks); chlorine is univalent (one hook); so one molecule of their compound contains one atom of Ca and two of Cl, and we write it $CaCl_2$. A compound of aluminum and chlorine is written $AlCl_3$. A compound of carbon and chlorine is written CCl_4.

When we write the composition of any substance in this abbreviated form, using the chemical symbols for the different atoms, and numbers to indicate how many atoms of each we have, we are writing a formula. H_2O is the formula for water, and using this way of writing we can go on indefinitely no matter how complicated substances become, or how many different kinds of atoms are joined together in one molecule. Sulfuric acid is H_2SO_4. Ordinary sugar, or sucrose, as the chemist calls it, is $C_{12}H_{22}O_{11}$. Chlorophyl, the complex green coloring matter in the leaves of plants, has the formula $C_{55}H_{72}O_5N_4Mg$. The formulas for those exceedingly complicated animal substances known as proteins, or the formula for rubber, may have anywhere up to 10,000 atoms in them, mostly carbon, hydrogen and oxygen.

The chemist does not always talk in symbols and formulas; he wants to have a system also of describing compounds in words and of indicating with these words how the compound is made up. Gradually almost a whole new chemical language has grown up, and this has not happened just by accident. It has been very carefully thought out, for the chemist, like all scientists, works very definitely and precisely.

To give you an idea of this language we shall try to describe very broadly the different types of compounds that exist; and especially try to show you how the chemist has put a system into the names he uses, which makes it possible for him to go on and make up the right name that correctly describes any compound, no matter how complicated.

CHEMISTRY IS DIVIDED INTO THE STUDY OF ORGANIC AND INORGANIC SUBSTANCES

But first, let us explain one more thing: when chemistry first came to be studied, people thought that there was something very different in principle between the chemistry of living matter and the chemistry of metals, gases, salts and minerals. So they called the chemistry of living matter organic chemistry; and the other they called inorganic chemistry. They thought that in the chemical reactions that go on in living organisms—in plants or animals—something extra happened, something mysterious, connected with life, and not present in metals or gases. We know now that this is not so, that there is no fundamental chemical difference at all, only that carbon is an element largely involved in living organisms. Now carbon has many more "tricks up its sleeve" than other elements, and there is an enormously great variety of compounds that contain carbon. This makes the naming of all of them a much more difficult problem that calls for great ingenuity. And so, even though we know that there is no real difference we still keep organic and inorganic chemistry separate in our textbooks. Let us have a look first at the less complicated of the two—inorganic chemistry.

The simplest compounds are those that contain only two different kinds of atoms; we generally give them names that end in *ide;* and we always put first the metal or the atom that behaves as a metal. Salt, $NaCl$, becomes sodium chloride; quicklime, CaO, is calcium oxide; the mineral galena, PbS, is lead sulfide. The compound of calcium and carbon which we used so much years ago to make the gas acetylene, is called calcium carbide, CaC_2.

Compounds of metal with hydrogen are hydrides. Compounds with oxygen are oxides. Compounds with nitrogen are nitrides. Compounds with phosphorus are phosphides. Those with fluorine, bromine or iodine are fluorides, bromides and iodides; and because these three elements with chlorine are also known as the halogens, these compounds are also known as halides.

Sometimes two elements can form two or more compounds with one another. In other words one or both of them behave as if they had two or more different valences. Then we have to find different names for these compounds and we do this in several different ways. Sometimes we use the Greek words as a basis for constructing new names:

mono—one
duo—two (dis—twice)
tri—three
tetra—four
penta—five
hexa—six
hepta—seven
octo—eight
ennea—nine
deca—ten

and so on. Thus we talk of carbon monoxide, CO, when there is only one atom of oxygen, and we speak of carbon dioxide, CO_2, when there are two atoms of oxygen to the carbon atom. $AlCl_3$ is aluminum trichloride, and CCl_4 (the cleaning fluid) is carbon tetrachloride. The two oxides of phosphorus, P_2O_3 and P_2O_5, are known as the trioxide and the pentoxide. UF_6 is uranium hexafluoride.

However, the Greek roots are not always used. Sometimes Latin forms are used instead. The yellow oxide of iron rust, Fe_2O_3, is known as sesquioxide, meaning that there are 1½ atoms of oxygen against every atom of iron. Sesqui is from the Latin word for one and a half. We talk of carbon dioxide, CO_2, and carbon disulfide, CS_2; but we call $HgCl_2$ bichloride of mercury, from the Latin *bis* which means twice, instead of from the Greek *dis*.

NAMES FOR DIFFERENT OXIDES OF THE SAME ELEMENTS

Still another way of expressing different compounds of the same two elements is by changing the ending of the first part of the name. The two iron oxides, FeO and Fe_2O_3, we call ferrous oxide and ferric oxide. The ending *ous* always indicates the lower valence, *ic* the higher one. In the same way P_2O_3, phosphortrioxide, is also known as phosphorous oxide; and P_2O_5, or phosphorpentoxide, is phosphoric oxide.

With nitrogen we have so many oxides that we have to use both methods. N_2O is nitrous oxide; NO is nitric oxide; NO_2 is nitrogen dioxide; N_2O_3 is nitrogen trioxide; and N_2O_5 is nitrogen pentoxide.

Passing on to compounds that contain three different kinds of atoms, we first come to the most important, those which contain both hydrogen and oxygen and one other element. When a substance dissolves, the molecules do not break apart into their original atoms; but, instead, pieces break off that are charged atoms, or groups of atoms. We call the pieces ions. An ordinary atom has no charge; it is electrically neutral, or balanced. When dissolving takes place, an atom may carry an electron from another atom with it, when it breaks free. Such an ion has a negative charge, and is called a negative ion. The atom losing the electron becomes a positive ion.

If a compound containing three different kinds of atoms splits in such a way as to liberate a hydrogen ion with a positive electric charge—really a proton, H^+—then we call it an acid. If it liberates an ion containing one oxygen and one hydrogen atom, plus an extra electron, OH^-, known as a hydroxyl ion, then we call it a base.

Perhaps the best known acid of all is sulfuric acid, H_2SO_4. This, when mixed with water, splits into H^+ and HSO_4^-; while the second part may split still further into another H^+ and $SO_4^=$.

But if we take sodium hydroxide, NaOH, and dissolve it in water it splits into Na^+ and OH^- and we call it a base.

ACID SOLUTIONS LIBERATE HYDROGEN IONS AND BASE SOLUTIONS FREE HYDROXYL IONS

Solutions in which there are a lot of H^+ ions (acids) have a strongly sour taste. Solutions with a lot of OH^- ions (bases) feel "sticky," and they even attack the human skin. For this reason sodium hydroxide is also called caustic soda, and similar bases are known as alkalies (an alkali is commonly called "lye"); we use the words acidity and alkalinity as opposites. The metals sodium, potassium, rubidium and others which give very strong bases are known as alkali metals. Calcium, barium and a few others whose bases are not so alkaline, but which occur in stone and earth, are known as the alkaline-earth metals.

Not all acids contain oxygen. Hydrogen chloride, HCl, also produces a lot of H^+ ions, or protons in solution. It is called hydrochloric acid and is the strongest acid known. HF, HBr, and HI are similarly known as hydrofluoric, hydrobromic and hydroiodic acid. If there are several acids known of the same element we again have to distinguish between them. We call H_2SO_4 sulfuric acid; but H_2SO_3 is sulfurous acid, -ic again meaning more oxygen atoms, -ous indicating fewer oxygen atoms per sulfur atom. Similarly, HNO_3 is nitric acid; HNO_2 is nitrous acid. If there are still more varieties we sometimes add the prefix *hypo-* (under) to the acid with the least amount of oxygen, and *per-* for the acid with the most oxygen.

WATER AND A SALT ARE THE PRODUCTS THAT RESULT FROM MIXING AN ACID AND A BASE

When acids and bases are mixed, something very interesting happens: the H^+ and OH^- ions unite into water, H_2O; and if we mix just the right amounts of sour-tasting hydrochloric-acid solution and sticky caustic-soda solution, we say that they "neutralize" each other—the result is neither sour nor sticky. Of course, there are other ions in that mixture—for if HCl splits off a positively charged H^+ ion, the remainder must be a negatively charged Cl^- ion; if NaOH splits off a negatively charged OH^- ion, the remainder must be a positively charged sodium ion Na^+. When we mix these two particular solutions the mixture gets very hot, for when H^+ and OH^- unite, to form water, they produce a lot of heat, though we do not see anything happen. The Cl^+ and Na^- ions are just interested bystanders, they do not mind each other. However, if we boiled the solution dry, getting rid of the water, we should have the compound NaCl left. Quite often we do not even have to do that: if we mix barium hydroxide, $Ba(OH)_2$, with sulfuric acid, H_2SO_4, then the Ba^{++} and $SO_4^=$ do not tolerate each other in the same solution. the compound $BaSO_4$ is insoluble in water and precipitates out (falls to the bottom as a solid).

NaCl is common salt. In chemistry we give the name "salts" to all such compounds, which are made up of the metal part of a base and the remainder of the acid after the hydrogen is split off. All these salts are again given names, with the metal mentioned first and then the indication of the acid. Salts of sulfuric acid are called sulf*ates*, but those of sulfurous acid sulf*ites*. Salts of nitric acid are nitrates; salts of nitrous acid are nitrites. Gypsum and plaster of Paris are mainly calcium sulfate, $CaSO_4$.

Sodium is only univalent—it has only one "hook"—so sodium sulfate has the formula Na_2SO_4. What happens if we mix in solution with sodium hydroxide (NaOH) a "double portion" of sulfuric acid (H_2SO_4)? Only one of the hydrogen atoms in the acid will change place with a sodium atom, thereby producing a salt, $NaHSO_4$, sodium bisulfate.

Limestone, $CaCO_3$, is calcium carbonate; and ordinary washing soda, Na_2CO_3, is known as sodium carbonate; baking soda, $NaHCO_3$, is called sodium bicarbonate; and $Ca(HCO_3)_2$ would be calcium bicarbonate, because we must mix "double portions" to get these salts.

When there is more than one acid for the same element, matters can become very complicated indeed. NaClO is called sodium hypochlorite; $NaClO_2$ is sodium chlorite. $NaClO_3$ is sodium chlorate; and $NaClO_4$ is sodium perchlorate. If in sodium sulfate, Na_2SO_4, we manage to replace one oxygen atom by another sulfur atom, so that it becomes $Na_2S_2O_3$, we now call that sodium thiosulfate (*thio* is from the Greek word for sulfur). But—before we really knew how this substance was put together—we had called it hyposulfite, and as "hypo" it is still known to the photographer.

It is not necessary to mix acids with bases to get salts; we can also get them by mixing two other salts. If we mix solutions of NaCl and $AgNO_3$, both of which are easily soluble in water, we immediately get a thick cheese-like precipitate of silver chloride, AgCl. What happens is that in the two solutions we have Na^+, Cl^-, Ag^+, and NO_3^- ions moving around. But silver chloride, AgCl, is insoluble in water, so Ag^+ and Cl^- can not stand each other in any solution. Double decomposition takes place; the silver chloride precipitates out of the solution. If we pour the remaining solution off and boil it dry we would get a new sodium salt: sodium nitrate, $NaNO_3$.

AN EQUATION IS A SHORT WAY OF TELLING WHAT HAPPENS IN A CHEMICAL REACTION

Rather than explain everything in words, as we have been doing, the chemist uses a shortcut. He writes in *equations*. Thus.

$$NaCl+AgNO_3 \rightarrow AgCl+NaNO_3$$

This really tells the story just as clearly, if not more so, and in much less space. The sign → means here "is equal to." We must watch out for one thing: the same number of atoms of each kind must appear on both sides of the equation. However, if we pass chlorine gas over iron wire, to make iron chloride, we can not write simply $Fe+Cl_3 \rightarrow FeCl_3$. That would not be correct. Chlorine gas does not contain atoms of chlorine, but molecules, each of which is composed of two atoms each. So we must write: $2Fe+3Cl_2 \rightarrow 2FeCl_3$. If we throw metallic sodium on water it produces caustic soda and hydrogen gas—whose molecules also contain two atoms of hydrogen each; therefore we must write:

$$2Na+2H_2O \rightarrow 2NaOH+H_2\uparrow$$

the upward arrow ↑ indicating that the hydrogen escapes as a gas. A downward arrow ↓ indicates precipitation.

Mixing a solution of calcium chloride, or chloride of lime, with a solution of sodium carbonate, or soda, results in the precipitation of calcium carbonate. This is represented by $CaCl_2+Na_2CO_3 \rightarrow CaCO_3\downarrow+2NaCl$.

The production of hydrogen from metallic zinc and sulfuric acid is written:

$$Zn+H_2SO_4 \rightarrow ZnSO_4+H_2\uparrow$$

The making of carbon dioxide from marble and hydrochloric acid as

$$CaCO_3+2HCl \rightarrow CaCl_2+H_2O+CO_2\uparrow.$$

ORGANIC FORMULAS TELL THE NUMBER OF ATOMS AND HOW THEY ARE ARRANGED

Organic chemistry is a far more complicated branch of chemistry than inorganic; and we can not use the same simple way of writing formulas. In inorganic chemistry there is only one compound whose molecules contain one atom each of calcium and oxygen —quicklime, or calcium oxide, CaO. But in organic chemistry the case is different. The same groups of atoms may combine, in many different ways, to make different molecules. C_2H_2 is acetylene, a gas; C_6H_6 is benzene, a liquid, an entirely different substance, and the two have nothing at all in common. Yet they contain the same atoms, combined in the same proportions. That such things occur is due to the very unusual behavior of carbon—its atoms apparently have a strong attraction for one another. The attraction is so strong that they form both chains and rings. Sometimes these chains are of very great length, as in rubber. So the formulas of organic chemistry, that is carbon chemistry, must be written in such a way as to show, not only how many atoms of each kind there are in every molecule, but also how these atoms are arranged; how they are "linked" and where. Such a formula is known as a structural formula.

Substances where the carbon atoms are arranged in long chains—with or without little side links—and those where the carbon atoms are arranged in rings have quite different behavior. So we generally divide carbon compounds into two groups. The chain, or aliphatic, compounds (from the Greek word for fats) include gasoline, fats, starches, sugars and proteins. The second group is the cyclic, or ring, compounds, sometimes also called aromatic compounds, because to them belong so many substances with strong odors, like benzene, naphthalene, phenol and carbolic acid.

Compounds that contain exactly the same number of atoms of certain elements but have these atoms differently arranged are called *isomers*. Compounds such as acetylene and benzene, where the proportion of the atoms is the same, but not the actual numbers, are *polymers*. Sometimes it is possible to build up a very complex molecule by having a number of identical molecules of simpler composition unite among themselves, and go through some rearrangements of their atoms inside. If this happens without any change in the proportions of the several chemical elements in the molecule we speak of *polymerization*. This is a very important process in the making of synthetic rubber.

By WILLEM J. LUYTEN.

THE NEXT STORY OF SCIENCE IS ON PAGE 5569.

A DICTIONARY OF COMMON CHEMICAL TERMS

Acid—a chemical compound, containing hydrogen, which has the property of releasing a positively charged hydrogen ion (H^+) when in solution with water. Acids are sour-tasting; they react actively with metals.

Alkali—a popular name for a substance that will free hydroxyl ions (OH^-) when in solution with water; also called lye.

Alkali metals—some metals, like sodium and potassium, which form very strong bases.

Alkaline-earth metals—some metals, like calcium and barium, whose bases are not very strong. They are found in stone and earth.

Base—a chemical compound which has the property of releasing an hydroxyl ion (OH^-) when in solution with water. It will neutralize an acid, forming water and a salt.

Chain (*aliphatic*) *compounds*—chemical compounds, containing carbon, arranged in long chain-like molecules.

Hydroxyl ion—a negative ion (OH^-) composed of one hydrogen atom, one oxygen atom and an extra electron. It is found in bases.

Hypo—a prefix used to distinguish among acids of the same element. It refers to the acid with the least amount of oxygen. Used alone it refers to the chemical known as sodium hyposulfite (or what is the same, sodium thiosulfate) used greatly in photography.

-ide—an ending generally used in forming the word which describes chemical compounds of two elements; for example, sodium chloride.

Inorganic chemistry—the less complicated of the two divisions of chemistry. It is the opposite of organic chemistry and was originally thought to be the chemistry of non-living substances.

Ion—an atom (or group of atoms) that has an electric charge, either negative or positive. The word itself means *go-er*, that is, the atom is free to go to (or be joined by) another atom of opposite charge.

Isomers—two or more compounds that contain the same number of atoms of certain elements, but have the atoms differently arranged.

Organic chemistry—the chemistry of carbon compounds. It is the more complicated of the two divisions of chemistry, and the opposite of inorganic chemistry.

Per—a prefix used to distinguish among acids of the same element. It refers to the acid with the greatest amount of oxygen.

Polymers—two or more compounds that contain the same atoms in the same proportions, but not the same numbers. For instance, acetylene, C_2H_2.

Precipitate—a substance separated by chemical action from a solution because it will not dissolve in that solution; a substance that falls to the bottom of a solution because it is insoluble in that liquid.

Ring (*cyclic*) *compounds*—chemical compounds containing carbon atoms, arranged in circular formation.

Salt—the name given in chemistry to a compound made up of the metal part of a base and the remainder of an acid when the hydrogen is split off. It commonly refers to sodium chloride, $NaCl$, or table salt.

Solution—a liquid form of the combination obtained by uniting a non-liquid and a liquid; a mixture in the liquid state.

A LOAD OF SWEETNESS IN VENEZUELA

Grace Line

A sturdy mule hauls a load of sugar-cane to a mill in the coastal lowlands of Venezuela. In this region of the country, which has a warm, moist climate, there are about 18,000 sugar plantations which grow cane for home use.

WHERE SUGAR COMES FROM

Courtesy, American Sugar Refining Company

Molding sugar cones in the seventeenth century. When you wanted sugar you broke a piece off the cone and crushed it.

BOYS and girls, and grown people too, are extremely fond of sugar, and this is quite as it should be, for sugar is an important food. It is one of the carbohydrates, the substances that supply our bodies with energy, just as gasoline produces the energy that drives an automobile. It is quite possible to eat too much sugar, just as it is possible to eat too much of any other food, but sugar in some form is needed to keep our bodies and minds healthy and active.

There are many different kinds of sugar. If you were asked what these different kinds are, you might think of the glittering white grains or cubes that we use on our dining tables, the finely powdered sugar with which frostings and confectionery are made, and the soft, sticky brown sugar which is so good when spread on bread and butter. These, however, are all the same kind of sugar, the kind that the chemists call "sucrose."

All sugars are made up of carbon, hydrogen and oxygen combined in different proportions and in different ways. They are found in many living things, both vegetable and animal. The sap of many trees contains sugar. Peaches, grapes and oranges are sweet because they contain sugar. So are honey and milk. Grains are made up partly of sugar. Onions, beets, peas and other garden vegetables contain sugar. Many flowers contain sugar, which is eagerly sought by the bees. Not all of these sugars are alike, and the same fruit, or other substance, may contain several kinds of sugar, not all of which can be used for the same purposes.

The kinds of sugar that are best known and most commonly used are sucrose, dextrose or glucose, lactose, maltose and levulose. Sucrose is obtained principally from sugar-cane and sugar-beets. Maple sugar is also a sucrose, and it would be possible to refine it down to white crystals like those of cane and beet sugar. This is never done because it would be too expensive, and because we should then lose the maple flavor, which is the best thing about maple sugar.

Dextrose, or glucose, is obtained principally from corn; lactose is milk-sugar; maltose comes from malt; and levulose, or fructose, from fruits, cane and beets. Some of these sugars are very difficult to crystallize, and are often used in syrup form. Corn syrup, one of the commonest of these, is much used in the making of confectionery and other foods in which an extremely smooth texture is desired. Sugar that crystallizes more readily tends to give a more grainy texture. Another sugar that is popular in some parts of the United States is the syrup or molasses made from sorghum, another of the cereal grasses, like corn and sugar-cane.

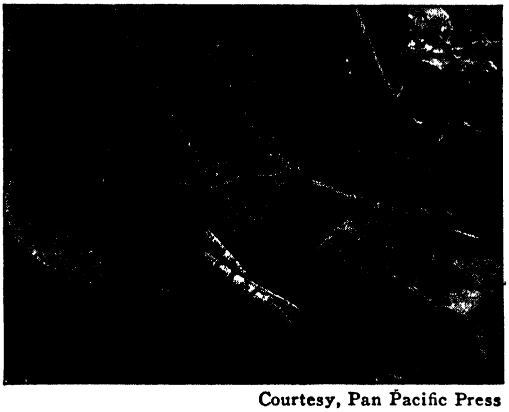
Nowadays sugar is so plentiful and so inexpensive that we look upon it as quite a common thing, but this has not always been so. In 1742, when George Washington was a ten-year-old boy, the market price of sugar was $2.75 a pound, and many people could not afford to have it at all. For many hundreds of years most people obtained the sugar necessary for a healthful diet by eating sweet fruits or honey.

Cane sugar was known to the ancient Egyptians, and it was from the valley of the Nile that the Arabs brought it to Sicily, whence the knowledge of it spread to other parts of Europe. It was also made in India long before the time of Jesus, and in the seventh century A.D., the Emperor of China sent ambassadors to India to learn how to make sugar from the sugar-cane. This early sugar was like a soft brown paste, for it was not until much later that people learned how to remove all the impurities and completely crystallize the sugar. In the fifteenth century a citizen of Venice was awarded one hundred thousand crowns (about $112,000) for inventing a method of molding sugar into loaves, and for a long time people bought sugar in large loaves from which they would break off and crush whatever amounts they needed.

Sugar-cane is a subtropical plant, and could only be cultivated in warm countries. In the fifteenth century it was introduced into the Canary Islands, and from there was brought to Brazil, the West Indies and Mexico. The Jesuit missionaries brought it from Mexico to Louisiana, and in 1794 was started the first commercial production of sugar in what is now the United States.

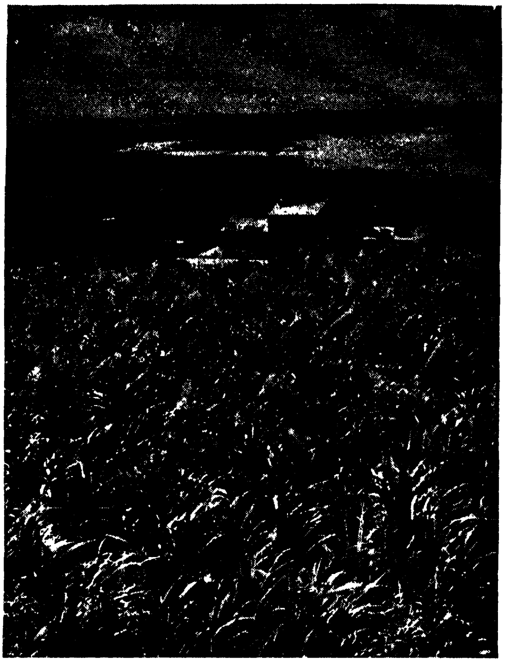
Northern countries, where the cane could not be grown, had to import their sugar, and in time of war the supply was often seriously interfered with. This is what led to the discovery and development of beet sugar.

In 1747 Andreas Marggraf, a German chemist, proved that beet roots contained a sugar which was exactly like that of the sugar-cane. Forty years later, Franz Karl Achard, who had been a pupil of Marggraf, planted sugar-beets and succeeded in producing sugar from them. It was in France, however, that beet sugar was first made on a large scale, and it was a decree of the Emperor Napoleon that brought the industry into being.



Courtesy, Pan Pacific Press

Tractors draw planters which drop the cane "seed" (joints cut from canes), cover it and pat the soil in place, all in one operation. The cane cannot be harvested by machinery, however, but must be cut by hand.



Courtesy, Pan Pacific Press

A sugar plantation in Hawaii, overlooking Pearl Harbor. Hawaii is an important producer of sugar cane, much of which is refined in the United States.

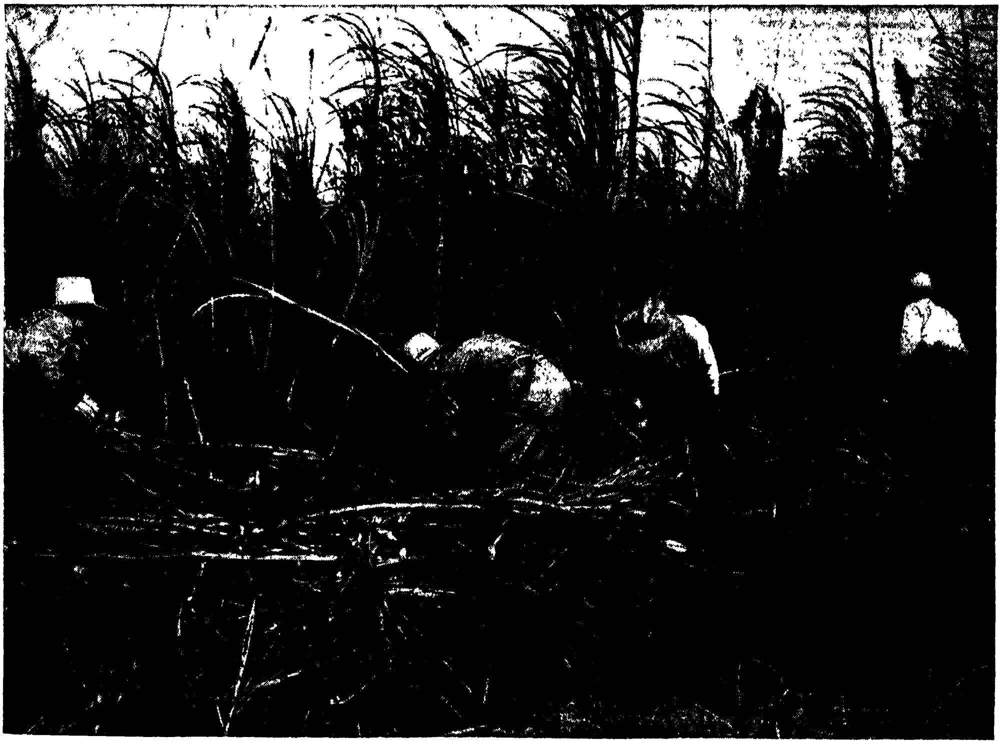
Napoleon was then at war with half the civilized world, and the British blockade made it very difficult to import sugar from the West Indies, so Napoleon had the French chemists try very hard to find a way to make good sugar from plants which could be grown in France. When, in 1811, the Imperial Pharmacist, Deyeaux, showed the Emperor some loaves of fine white sugar made from beets, Napoleon ordered thousands of acres of beets to be planted. Within a year France had forty factories producing more than three million pounds of sugar.

Several attempts were made to produce beet sugar in the United States during the nineteenth century. One factory was started in Massachusetts in 1838, and another was established in Utah by the Mormons in 1852. In Illinois, Colorado, California and several other states efforts were made to establish the beet sugar industry, but it was not until the 1890's that real success was achieved.

To-day about thirty-five per cent of the world's output is beet sugar, and sixty-five per cent is cane sugar. Four-fifths of the sugar refined in the United States is cane sugar, grown in Louisiana, Cuba, Puerto Rico, Hawaii and the Philippines. Most of

BURNING OFF AND HARVESTING

The cane stalks do not all grow straight up; some lie along the ground for part of their length. In some cases when the cane is ripe, the field is set on fire. The tangleweeds burn, but not the ripe canes full of sweet juice.

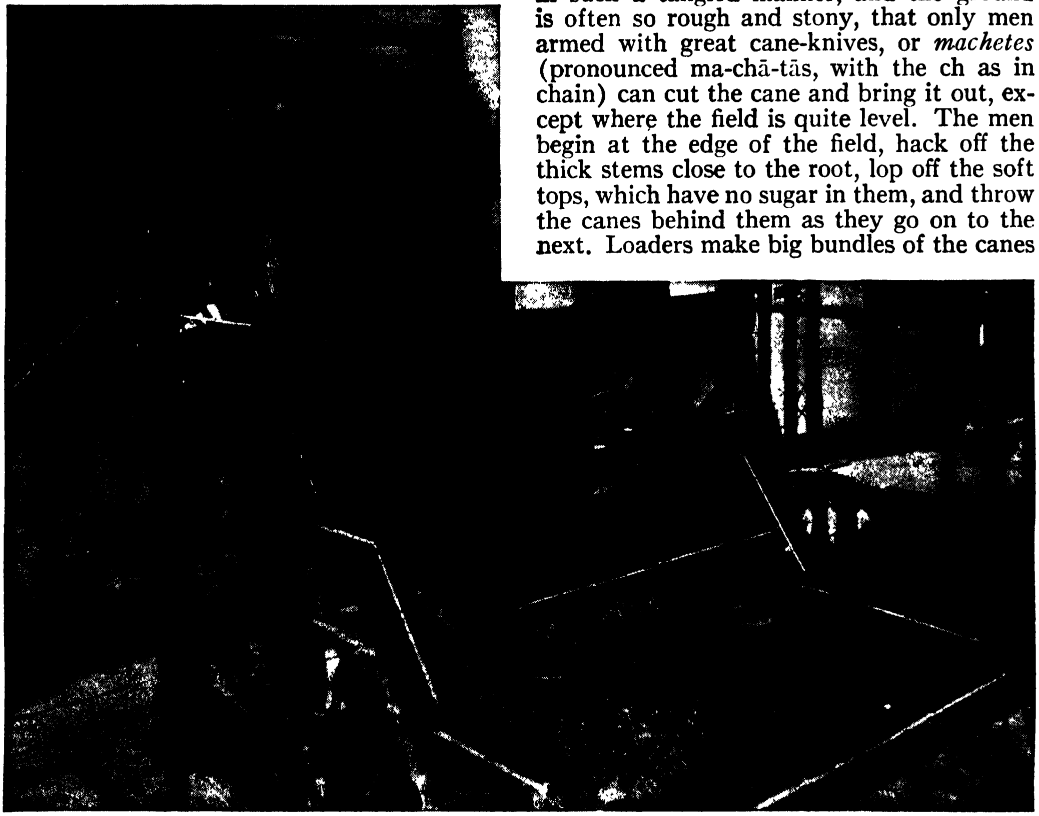


Pictures, courtesy, Pan Pacific Press

The sugar is best harvested by hand. These workers, with their big knives (machetes) are hacking off the stalks, then cutting off the tops which have no sugar. Behind them come loaders to bundle the stalks for the mill.

the beet sugar refined in the United States comes from California, Colorado, Michigan, Montana, Idaho, Utah and several other western states. In Canada beet sugar is grown and refined in parts of Alberta and Ontario but the greater part of the sugar used in the Dominion is imported.

The cane from which we get our sugar is really a giant grass with a smooth, jointed stem that grows from eight to twenty-eight feet long. It has long, slender leaves, and at the top of the stalk grows a feathery tuft which contains seeds. The stalks do not always stand straight up; sometimes a long stalk will run along the ground for almost twenty feet and then turn straight up in the air for the last four or five feet. You can imagine how tangled this makes a cane field, and it explains why harvesting the cane is such hard work.



Courtesy, American Sugar Refining Co.

After the cane has been washed, it is chopped and mashed and carried to the top of the first crusher, or shredder. This has two rollers, the first with coarse teeth, the second with finer ones. The rollers press and tear the cane and squeeze out more than half of the juice. Other mills crush and squeeze until all juice is out.

Sugar-cane is seldom planted from seed. It is easier to plant pieces of the stalk, for new plants will grow from the joints of the stalk cuttings if they are planted in furrows and kept moist and warm. When the cane is ready, the field may be set on fire to burn out all the tangle of dead leaves and bits of dry stalk. This does not hurt the ripe cane at all, for it is so full of the sweet juice that it will not burn.

Although many machines have been devised to cut and harvest the cane, they are not in general use, for sugar-cane grows in such a tangled manner, and the ground is often so rough and stony, that only men armed with great cane-knives, or *machetes* (pronounced ma-chā-tās, with the ch as in chain) can cut the cane and bring it out, except where the field is quite level. The men begin at the edge of the field, hack off the thick stems close to the root, lop off the soft tops, which have no sugar in them, and throw the canes behind them as they go on to the next. Loaders make big bundles of the canes and then they are sent to the plantation mill. Sometimes they go by railroad, sometimes they are floated there in water-flumes —long, narrow open troughs through which water flows.

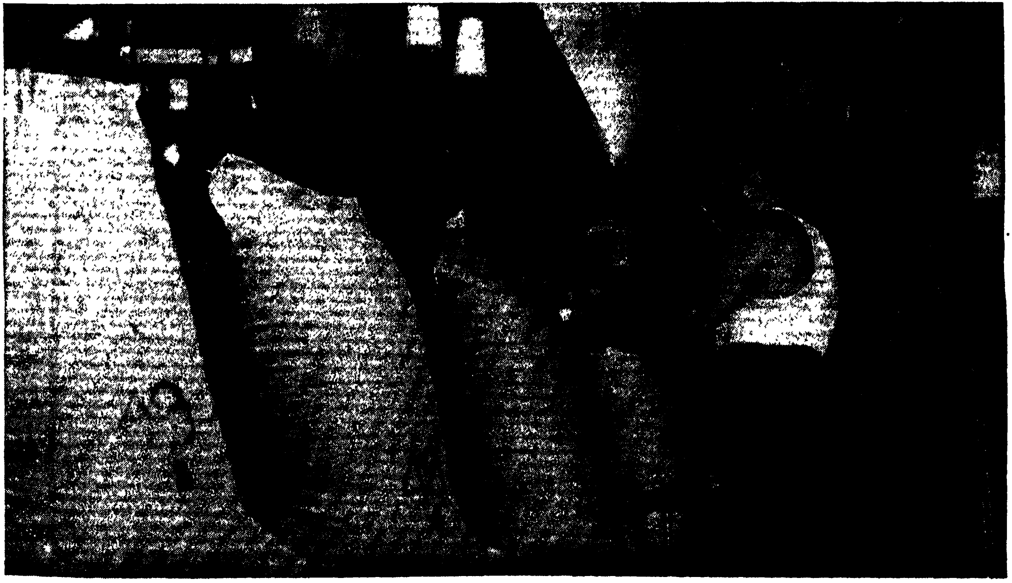
When the cane arrives at the mill it is placed in special cane washers, to get rid of the mud and trash, and then weighed. Then it moves on mechanical conveyors while great blades chop and slash the cane to make it ready for the first crushers. This

IN A HAWAIIAN SUGAR MILL

Top. The sweet juice is boiled in huge vacuum pans until much of the liquid goes off in steam and crystals begin to form in a thick brown liquid, molasses. Right. The molasses goes to whirling machines which throw the molasses off, leaving the sugar crystals.

Pictures, courtesy, Pan Pacific Press

Below. The raw sugar pours down through a funnel into bags which are automatically sewn up as they are filled. The raw sugar then goes to the refinery.

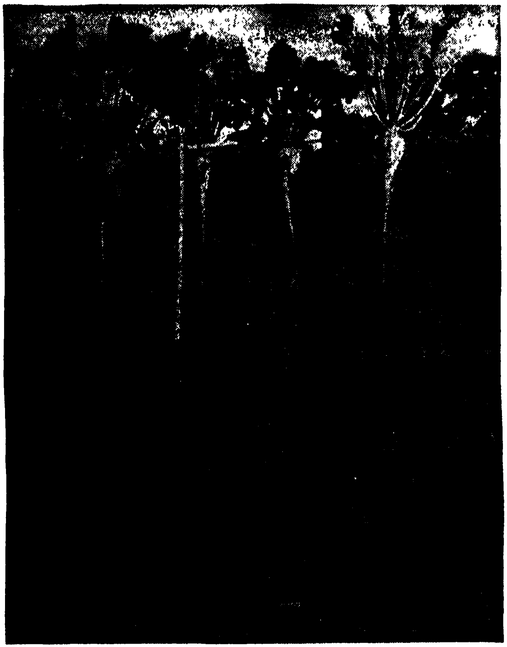


first crusher or shredder has two large rolls with interlocking teeth. When the chopped cane passes through these rolls, they exert a pressure of 450 tons, squeezing out nearly sixty per cent of the juice, which runs down into a tank.

This is just the beginning of the squeezing process, for the cane, which is now a smooth, moist mat, is next put through a long series of rolls, each of which crushes it a little harder, and presses out a little more juice. At the end, nothing is left but the fibrous, woody part of the cane, called *bagasse*. This is used as fuel to supply the mill furnaces, and if there is any left over it can be sold to make wall board and other fibre products.

The juice is pumped up to the top of the mill, where it is mixed with a lime solution to keep it from fermenting, and placed in settling tanks. After it has settled and has been filtered, it is a clear liquid made up of about eighty-five per cent water and fifteen per cent solid matter. It is this solid matter that is crystallized into sugar when all the water is driven out.

This is done by means of an intricate process of boiling the liquid in a series of evaporators and vacuum pans, reducing the liquid to a thick mass of sucrose crystals and "mother liquid." The mother liquid consists of molasses and other impurities. The sticky brown mass then goes into a centrifuge. This is a vessel which whirls around at a speed equal to more than 120 miles an hour, throwing the liquid out through a screen, and leaving only the crystals. These crystals are called "raw sugar," and after being carefully tested for purity, they are packed in bags and shipped to the refineries. Sometimes the refineries are quite near the cane fields, as in Louisiana, but the sugar that is grown in Hawaii and other places beyond the seas must often travel thousands of miles before it reaches the refineries.



Courtesy, Great Western Sugar Co.

Sugar beets growing. These are not the small red vegetables which we eat, but are large white roots specially grown for their sugar.

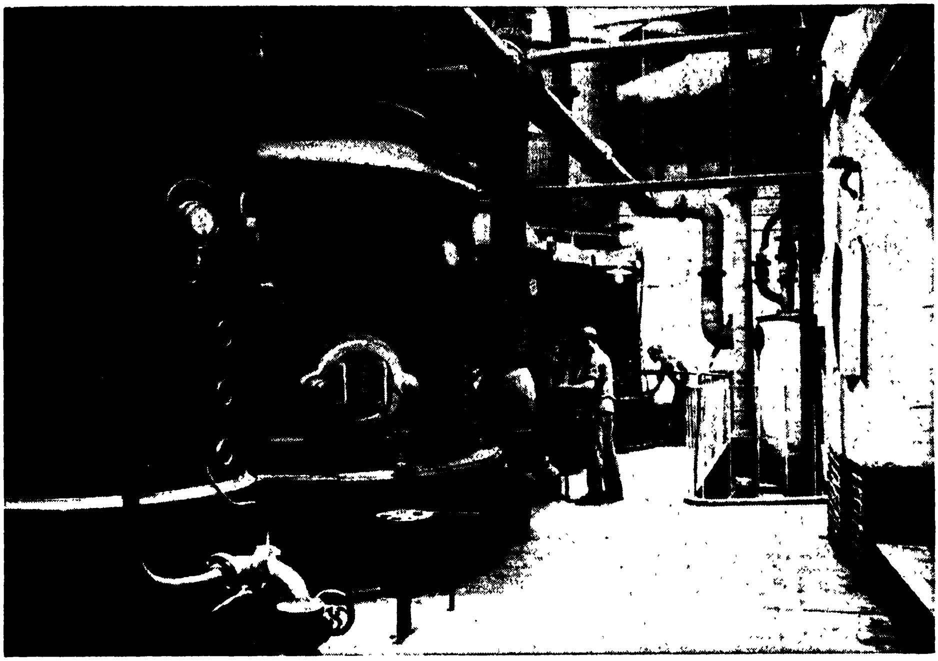
When the sugar comes to the refinery it is about ninety-six per cent pure sucrose. To make it entirely pure, it is again crushed, washed, whirled in centrifugal machines, and melted into a clear yellow liquid. Then it is put through the "char filters" to make it white. A char filter is a tank filled with bone charcoal. As the liquid sugar seeps down through this charcoal all of the remaining impurities stick to the charcoal, leaving the syrup pure and colorless. It is now ready to go to the vacuum pans again to be evaporated, and to other centrifugal machines. The final product, snow-white crystals, is dried, sifted through screens into bins for the different sizes of crystals, and packed ready for us to use.

Brown sugar, which comes in different shades, from pale yellow to a dark, rich brown, is sugar that has not had all of the molasses taken out. Powdered sugar is the pure sucrose crystals finely ground. The flat, oblong tablets that we use in tea and coffee are made by forming the white crystals into large slabs, which are sawed and then clipped to the proper size. The cube-shaped tablets are often moulded and pressed into shape instead of being cut from slabs.

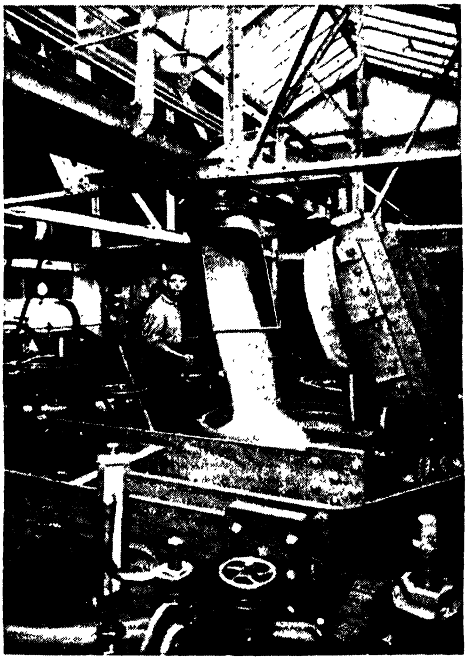
Beet sugar is made in much the same way as cane sugar, but it can be boiled to the required purity, and does not have to have the color filtered out by the charcoal process. On the other hand while cane sugar is good to eat at every stage of the refining process, beet sugar cannot be eaten until everything but the sucrose crystals has been removed.

The beets from which our sugar comes are large white roots, not the small red ones that we eat as vegetables. The sugar mills are usually located near the fields. The raw beets go in at one end of the mill and the refined sugar goes out at the

HOW SUGAR IS MADE FROM BEETS



The beets are washed clean, and after being sliced up they are placed with hot water in the large iron vessels seen here, called diffusers, where the sugar is dissolved out of the beets. The water passes through cylinder after cylinder, at each stage becoming more saturated with sugar.

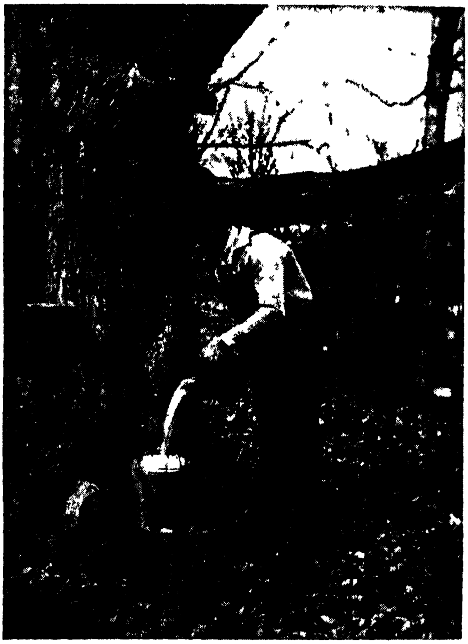


The syrup from the beets is passed to vessels where it is mixed with lime to get rid of impurities.

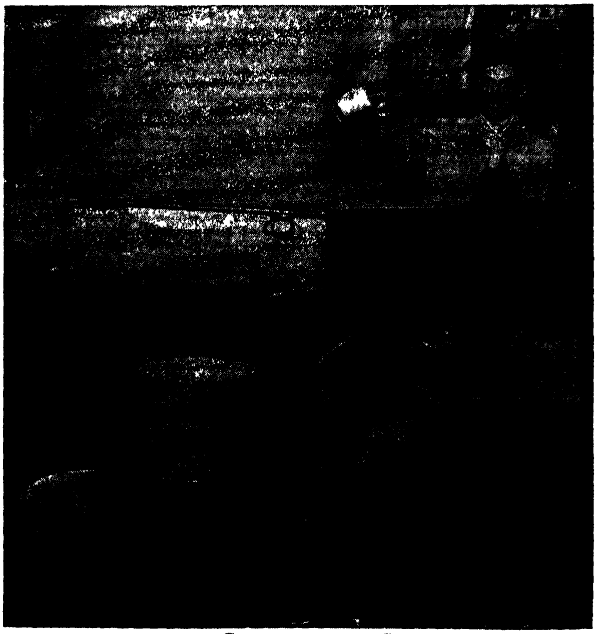
This shows the great pumps that drive the syrup through pipes to different parts of the factory.

OBTAINING SUGAR FROM THE MAPLE TREE

Millions of pounds of sugar are obtained each year from the maple tree. In early spring, when the sap is rising, holes are bored in the trunks.



Pails are hung beneath the holes to catch the sweet sap as it oozes out. A tree gives most sap when it is thirty to forty years old.



Pictures, courtesy, Canadian Pacific Railway

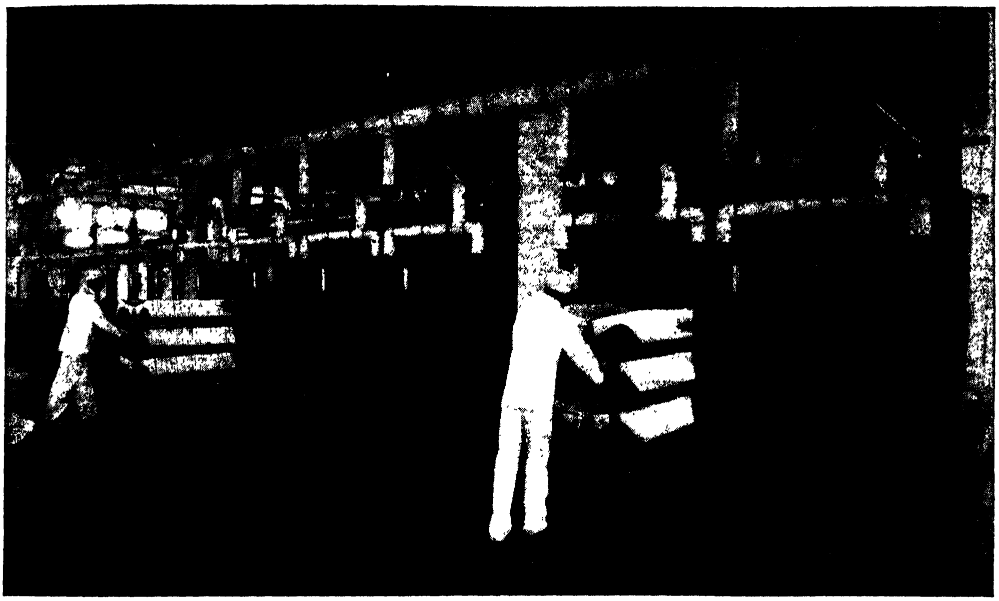
In the morning a man goes around emptying the pails and replacing them To transform sap into sugar, it was formerly boiled in great iron kettles over a wood fire. The scum was removed and the sugar crystallized as it cooled. Here we see a modern method of boiling the sap, in tanks built over a big wood oven.

other end. The process that takes place inside is a marvel of modern chemistry.

When the beets reach the mill they are washed, weighed and sliced by machinery into long strips called *cossettes,* or chips. These are tumbled into tanks, where the sugar is drawn from them by hot water, and the pulp is removed, later to be made into cattle fodder. The raw juice is then treated with lime and carbon dioxid gas to take out the impurities, which are made into a fertilizer for the soil. This process produces a juice which contains from ten to twelve per cent of sugar. This must be concentrated, so it is put through a series of five evaporators, in which it is boiled down until fifty-five per cent of the liquid is sugar. After it has been carefully filtered, it goes to the vacuum pans to be crystallized, just as cane sugar does. At last the mixture of white crystals and syrup, called *white massacuite,* is placed in the centrifugal machines, from which comes the finished product to be dried and packed.

This process has been described as simply as possible, but it is really very complicated. Every step is carefully controlled by the chemists, and tests are continually being made as the work progresses. You will notice that nothing is wasted in the making of beet sugar. After every bit of sucrose is taken out of the beets the pulp and molasses are used for feeding sheep and cattle, and the other substances are used to enrich the land for the farmers.

When the early colonists came to America they found that the Indians made sugar from the sap of some maple trees (*Acer saccharum*), and they soon learned to value this delicious sweetening. To-day, although the methods have been improved, maple sugar is still made in much the same way as it was long ago. Just before the sap rises in the spring, holes are bored in the trees, tubes are driven in, and pails are hung on them to catch the sap as it drips from the holes.



Courtesy, American Sugar Refining Company

Slabs of sugar, which will later be cut into little "lumps" as we call them, are being wheeled into ovens, for drying. Processes in refining cane sugar and beet sugar are quite similar, and the sugar from the two sources cannot be told apart. Beet sugar molasses cannot be used in cooking.

The sap that is collected is boiled, sometimes in the open air in great iron kettles, and sometimes indoors in evaporating vats. When the sap has thickened enough, it turns to sugar, just as the cane and beet juices do. If maple syrup is desired, the evaporation is stopped before the sugar has a chance to crystallize. When the sugar begins to crystallize, it is poured into molds to harden.

The sugar maple tree grows all over eastern North America, from Newfoundland to Georgia, but Quebec and Vermont produce the largest amount of maple sugar.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5574.

Why Does Sugar Dissolve More Quickly in Hot Water than in Cold?

WHEN one substance dissolves in another, their molecules mingle. Two gases will generally mingle easily, for there are plenty of spaces between the molecules of one, among which the molecules of the other can push. Two liquids will generally mix easily, water and milk, for instance. (There are exceptions to this rule, as you know. Water and oil do not mix.) One solid will not dissolve in another, for the molecules of each hold together too tightly to allow such a process to take place. A gas may be dissolved in a liquid: and many solids will dissolve readily in liquids. Sugar is one of them. It will dissolve more quickly in a hot liquid than in a cold liquid, chiefly because the molecules of the hot liquid are farther apart than those of the cold liquid, and so the sugar molecules can more easily push between.

WHY IS SUGAR SWEET?

There is a certain well-marked part of the surface of the brain that is the real seat of the sense of taste. From, or to, this place there run at least four, perhaps more, sets of nerves, the ends of which are in the taste-buds of the tongue and part of the throat. One set of these nerves, when it is excited, arouses in the brain the sensation that we call a sweet taste, and one substance that specially excites this particular set of nerves is sugar.

Sugar is really a name for a closely related group of chemical substances that are sweet-tasting, though some are less so than others —for instance, milk sugar. But not all sweet things belong to this chemical group. Saccharin, for example, which some people use instead of sugar, is utterly different from sugar chemically, yet it is sweeter than any sugar.

WHY DOES TEA RUN UP THROUGH A LUMP OF SUGAR?

Hold a lump of sugar on a fork so that the bottom of the lump just touches the tea. What happens? Soon the tea rises up through the lump and softens it. Why?

When water, and watery things like tea, come in contact with a surface on which they can spread themselves, they do so. We must think of the sugar as if it were a lot of little tubes all put together, and then it is easy to show, by a simple experiment, what happens.

If we take a thin glass tube and dip it into water, the water will spread itself out on the inside surface of the tube, and will rise a little higher in the tube than outside; and where the water stops it will have a cup-shaped surface, because the water all round, where it is next to the glass, creeps up the glass a little. It is just this that happens when tea runs up through a lump of sugar. We call this rising of a liquid through a tube, capillary action.

IS SACCHARIN A SORT OF SUGAR?

No, saccharin is not sugar. It is not a food. It has no fuel, or energy, value such as sugar has. It is a complicated chemical compound, 500 times as sweet as sugar. It can not be digested by the body, nor stored in the body, and for that reason is advised in certain cases of illness. People who have diabetes, for instance, must control the amount of sugar they eat. A very small tablet of saccharin will sweeten their tea or coffee without entering the body's chemistry. This substance is also used as a sweetening agent by people who wish to control their weight. However, it should not be taken without a doctor's advice.

WHAT IS CONFECTIONERS' SUGAR?

Confectioners' sugar is simply sugar that has been highly refined and ground to a very light powder. It is much used in making candies, cake frostings and other foods where extra smoothness as well as extra sweetness is desired. Candies and frosted cakes used to be called confections and the man who made them was called a confectioner. That is how this sugar got its name. French-speaking people use similar words. They call confections *les confiseries;* and a confectioner, *le confiseur.* Perhaps you have used confectioners' sugar on fresh fruit, such as berries or peaches. Powdered sugar is more generally used for fruit. It is a little coarser than confectioners' sugar, yet finer than the regular granulated kind.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5465.

East of the Sun and West of the Moon[*]

Illustrated by Wanda Gág

Once on a time there was a poor husbandman who had so many children that he hadn't much of either food or clothing to give them. Pretty children they all were, but the prettiest was the youngest daughter, who was so lovely there was no end to her loveliness.

So one day, 'twas on a Thursday evening late at the fall of the year, the weather was so wild and rough outside, and it was so cruelly dark, and rain fell and wind blew, till the walls of the cottage shook. There they all sat round the fire, busy with this thing and that. But just then, all at once something gave three taps on the windowpane. The father went out to see what was the matter; and, when he got out of doors, what should he see but a great big White Bear.

"Good-evening to you!" said the White Bear.

"The same to you!" said the man.

"Will you give me your youngest daughter? If you will, I'll make you as rich as you are now poor," said the Bear.

Well, the man would not be at all sorry to be so rich; but still he thought he must have a bit of a talk with his daughter first; so he went in and told them how there was a great White Bear waiting outside, who had given his word to make them so rich if he could only have the youngest daughter.

The lassie said "No!" outright. Nothing could get her to say anything else; so the man went out and settled it with the White Bear that he should come again next Thursday evening and get an answer. Meantime he talked his daughter over, and kept on telling her of all the riches they would get, and how well off she would be herself; and so at last she thought better of it, and washed and mended her rags, made herself as smart as she could, and was ready to start. I can't say her packing gave her much trouble.

Next Thursday evening came the White Bear to fetch her, and she got upon his back with her bundle, and off they went. So, when they had gone a bit of the way, the White Bear said: "Are you afraid?"

"No," she wasn't.

"Well! mind and hold tight to my shaggy coat, and then there's nothing to fear," said the Bear.

So she rode a long, long way, till they came to a great steep hill. There, on the face of it,

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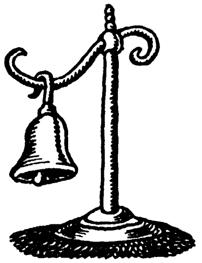
the White Bear gave a knock, and a door opened, and they came into a castle where there were many rooms all lit up; rooms gleaming with silver and gold; and there, too, was a table ready laid, and it was all as grand as grand could be. Then the White Bear gave her a silver bell; and when she wanted anything, she was only to ring it, and she would get it at once.

Well, after she had eaten and drunk, and evening wore on, she got sleepy and thought she would like to go to bed, so she rang the bell; and she had scarce taken hold of it before she came into a chamber where there was a bed made, as fair and white as anyone would wish to sleep in, with silken pillows and curtains and gold fringe.



All that was in the room was of precious gold or silver; but when she had gone to bed and put out the light, a man came and laid himself alongside her. That was the White Bear, who threw off his beast shape at night; but she never saw him, for he always came after she had put out the light, and before the day dawned he was up and off again. So things went on happily for a while, but at last she began to get silent and sorrowful; for there she went about all day alone, and she longed to go home to see her father and mother and brothers and sisters. So one day, when the White Bear asked what it was that she lacked, she said it was so dull and lonely there, and how she longed to go home to see her father and mother and brothers and sisters, and that was why she was so sad and sorrowful, because she couldn't get to them.

"Well, well!" said the Bear, "perhaps there's a cure for all this; but you must promise me one thing, not to talk alone with your mother, but only when the rest are by to hear; for she'll take you by the hand and try to lead you into a room to talk; but you must mind and not do that, else you'll bring bad luck on both of us."

So one Sunday the White Bear came and said now they could set off to see her father and mother. Well, off they started, she sitting on his back; and they went far and long. At last they came to a grand house, and there her brothers and sisters were running about out of doors at play, and everything was so pretty 'twas a joy to see.

"This is where your father and mother live now," said the White Bear; "but don't forget what I told you, else you'll make us both unlucky."

No! bless her, she'd not forget!—and when she had reached the house, the White Bear turned right about and left her.

Then, when she went in to see her father and mother, there was such joy there was no end to it. None of them thought they could thank her enough for all she had done for them. Now they had everything they wished, as good as good could be, and they all wanted to know how she got on where she lived.

Well, she said, it was very good to live where she did; she had all she wished. What she said beside I don't know, but I don't think any of them had the right end of the stick, or that they got much out of her. But so, in the afternoon, after dinner, all happened as the White Bear had said. Her mother wanted to talk with her alone in her bedroom; but she minded what the White Bear had said, and wouldn't go upstairs.

"Oh! what we have to talk about will keep!" she said, and put her mother off. But, somehow or other, her mother got round her at last, and she had to tell her the whole story. So she said, how every night when she had gone to bed a man came and lay beside her as soon as she had put out the light; and how she never saw him, because he was always up and away before the morning dawned; and how she went about woeful and sorrowing, for she thought she should so like to see him; and how all day long she walked about there alone; and how dull and dreary and lonesome it was.

"My!" said her mother; "it may well be a Troll you slept with! But now I'll teach you a lesson how to set eyes on him. I'll give you a bit of candle, which you can carry home in your bosom; just light that while he is asleep, but take care not to drop the tallow on him."

Yes! she took the candle and hid it in her bosom, and as night drew on, the White Bear came and fetched her away.

But when they had gone a bit of the way, the White Bear asked if all hadn't happened as he said.

Well, she couldn't say it hadn't.

"Now, mind," said he, "if you have listened to your mother's advice, you have brought bad luck on us both, and then, all that has passed between us will be as nothing."

No, she said, she hadn't listened to her mother's advice.

So when she reached home, and had gone to bed, it was the old story over again. There came a man and lay down beside her; but at dead of night, when she heard he slept, she got up and struck a light, lit the candle, and let the light shine on him, and so she saw that he was the loveliest Prince one ever set eyes on, and she fell so deep in love with him on the spot, that she thought she couldn't live if she didn't give him a kiss there and then. And so she did; but as she kissed him, she dropped three hot drops of tallow on his shirt, and he woke up.

"What have you done?" he cried in distress; "now you have made us both unlucky, for had you held out only this one year, I had been freed. For I have a stepmother who has bewitched me, so that I am a White Bear by day, and a Man by night. But now all ties are snapped between us; now I must set off from you to her. She lives in a castle which stands East of the Sun and West of the Moon, and there, too, is a Princess, with a nose three ells long, and she's the wife I must have now."

She wept and took it ill, but there was no help for it; go he must. She asked if she mightn't go with him.

No, she mightn't.

"Tell me the way, then," she said, "and I'll search you out; *that* surely I may get leave to do."

Yes, she might do that, he said; but there was no way to that place. It lay East of the Sun and West of the Moon, and thither she'd never find her way.

So next morning, when she woke up, both Prince and castle were gone, and there she lay on a little green patch in the midst of the gloomy thick wood, and by her side lay the same bundle of rags she had brought with her from her old home.

So when she had rubbed the sleep out of her eyes, and wept till she was tired, she set out on her way, and walked many, many days, till she came to a lofty crag. Under it an old hag sat and played with a gold apple which she tossed about. Her the lassie asked if she knew the way to the Prince, who lived with his step-mother in the castle that lay East of the Sun and West of the Moon, and who was to marry the Princess with a nose three ells long.

"How did you come to know about him?" asked the old hag; "but maybe you are the lassie who ought to have had him?"

Yes, she was.

"So, so; it's you, is it?" said the old hag matter-of-factly. "Well, all I know about him is that he lives in the castle that lies East of the Sun and West of the Moon, and thither you'll come, late or never; but still you may have the loan of my horse, and on him you can ride to my next neighbor. Maybe she'll be able to tell you; and when you get there, just give the horse a switch under the left ear, and beg him to be off home; and, stay, this gold apple you may take with you."

So she got upon the horse, and rode a long, long time, till she came to another crag, under which sat another old hag, with a gold carding-comb. Her the lassie asked if she knew the way to the castle that lay East of the Sun and West of the Moon, and she answered, like the first old hag, that she knew nothing about it, except it was East of the Sun and West of the Moon.

"And thither you'll come, late or never, but you shall have the loan of my horse to my next neighbor; maybe she'll tell you all about it; and when you get there, just switch the horse under the left ear, and beg him to be off home."

And this old hag gave her the golden carding-comb; it might be she'd find some use for it, she said. So the lassie got upon the horse, and rode a far, far way, and a weary time; and so at last she came to another great crag, under which sat another old hag, spinning with a golden spinning-wheel. Her, too, she asked if she knew the way to the Prince, and where the castle was that lay East of the Sun and West of the Moon. So it was the same thing over again.

"Maybe it's you who ought to have had the Prince?" said the old hag.

Yes, it was.

But she, too, didn't know the way. "East of the Sun and West of the Moon it was," she knew—that was all.

"And thither you'll come, late or never; but I'll lend you my horse, and then I think you'd best ride to the East Wind and ask him; maybe he knows those parts, and can blow you thither. But when you get to him, you need only give the horse a switch under the left ear, and he'll trot home of himself."

And so, too, she gave her the gold spinning-wheel. "Maybe you'll find a use for it," said the old hag.

Then on she rode many days, a weary time, before she got to the East Wind's house, but at last she did reach it, and then she asked the East Wind if he would tell her the way to the Prince who dwelt East of the Sun and West of the Moon. Yes, the East Wind had often heard tell of it, the Prince and the castle, but he couldn't tell the way, for he had never blown so far.

"But, if you will, I'll go with you to my brother the West Wind, maybe he knows, for he's much stronger. So if you will just get on my back, I'll carry you thither."

Yes, she got on his back, and they went briskly along.

So when they got there, they went into the West Wind's house, and the East Wind said the lassie he had brought was the one who ought to have had the Prince who lived in the castle East of the Sun and West of the Moon; and so she had set out to seek him, and how he had come with her, and would be glad to know if the West Wind knew how to get to the castle.

"Nay," said the West Wind, "so far I've never blown; but if you will, I'll go with you to our brother the South Wind, for he's much stronger than either of us, and he has flapped his wings far and wide. Maybe he knows the way to the castle. You can get on my back, and I'll carry you to him."

Yes! she got on his back, and so they traveled to the South Wind, and weren't so very long on the way.

When they got there, the West Wind asked him if he could tell her the way to the castle that lay East of the Sun and West of the Moon, for it was she who ought to have had the Prince who lived there.

"You don't say so! That's she, is it?" said the South Wind.

"Well, I have blustered about in most places in my time, but so far have I never blown; but if you will, I'll take you to my brother the North Wind; he is the oldest and strongest of the whole lot of us, and if he doesn't know where it is, you'll never find anyone in the world to tell you. You can get on my back, and I'll carry you thither."

Yes! she got on his back, and away he went from his house at a fine rate. And this time, too, she wasn't long on her way.

So when they got to the North Wind's house, he was so wild and cross, cold puffs came from him a long way off.

"Blast you both, what do you want?" he roared out to them ever so far off, so that it struck them with an icy shiver.

"Well," said the South Wind, "you needn't be so mad, for here I am, your brother, the South Wind, and here is the lassie who ought to have had the Prince who dwells in the castle that lies East of the Sun and West of the Moon, and now she wants to ask you if you ever were there, and can tell her the way, for she would be so glad to find him again."

"Yes, I know well enough where it is," said the North Wind; "once in my life I blew an aspen-leaf thither, but I was so tired I couldn't blow a puff for ever so many days after. But if you really wish to go thither, and aren't afraid to come along with me, I'll take you on my back and see if I can blow you thither."

Yes! with all her heart; she must and would get thither if it were possible in any way; and as for fear, however madly he went, she wouldn't be at all afraid.

"Very well, then," said the North Wind, "but you must sleep here in this house tonight, for we must have the whole day before us, if we're to get thither at all."

Early next morning the North Wind woke her, and puffed himself up, and blew himself out, and made himself so stout and big, 'twas gruesome to look at him; and so off they went high up through the air, as if they would never stop till they got to the world's end.

Down here below there was such a storm; it threw down long tracts of wood and many houses, and when it swept over the great sea, ships foundered by hundreds.

So they tore on and on—no one can believe how far they went—and all the while they still went over the sea, and the North Wind got more and more weary, and so out of breath he could scarce bring out a puff, and his wings drooped and drooped, till at last he sunk so low that the crests of the waves dashed over his heels.

"Are you afraid?" said the North Wind.

"No!" she wasn't.

But they weren't very far from land; and the North Wind had still so much strength left in him that he managed to throw her up on the shore under the windows of the castle which lay East of the Sun and West of the Moon; but then he was so weak and worn out, he had to stay there and rest many days before he could get home again.

Next morning the lassie sat down under the castle window, and began to play with the gold apple; and the first person she saw was the Long-nose who was to have the Prince.

"What do you want for your gold apple, you lassie?" said the Long-nose, and threw up the window.

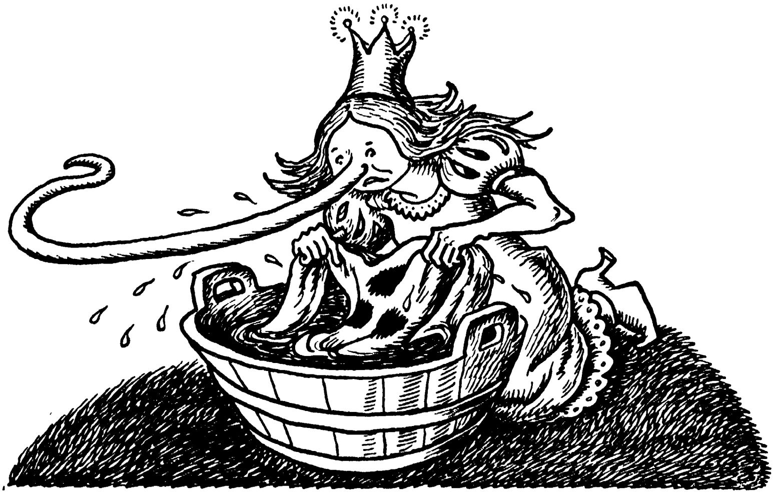
"It's not for sale, for gold or money," said the lassie.

"If it's not for sale for gold or money, what is it that you will sell it for? You may name your own price," said the Princess.

"Well! if I may get to the Prince, who lives here, and be with him tonight, you shall have it," said the lassie whom the North Wind had brought.

Yes! she might; that could be done; but when the lassie came up to the Prince's bedroom at night he was fast asleep; she called him and shook him, and between whiles she wept sore; but for all she could do she couldn't wake him up. Next morning, as soon as day broke, the Princess with the long nose came and drove her out again.

So in the daytime she sat down under the castle windows and began to card with her carding-comb, and the same thing happened. The Princess asked what she wanted for it; and she said it wasn't for sale for gold or money, but if she might get leave to go up to the Prince and be with him that night, the Princess should have it. But when she went up she found him fast asleep again, and all she called, and all she shook, and wept, and prayed, she couldn't get life into him; and as soon as the first gray peep of day came, then the Princess with the long nose chased her out again.



So, in the daytime, the lassie sat down outside under the castle window, and began to spin with her golden spinning-wheel, and that, too, the Princess with the long nose wanted to have. So she threw up the window and asked what she wanted for it. The lassie said, as she had said twice before, it wasn't for sale for gold or money; but if she might go up to the Prince who was there, and be with him alone that night, she might have it.

Yes! she might do that and welcome. But now you must know there were some Christian folk who had been carried off thither, and

as they sat in their room, which was next the Prince, they had heard how a woman had been in there, and wept and prayed, and called to him two nights running, and they told that to the Prince.

That evening, when the Princess came with her sleepy drink, the Prince made as if he drank, but threw it over his shoulder, for he could guess it was a sleepy drink. So, when the lassie came in, she found the Prince wide awake; and then she told him the whole story how she had come thither.

"Ah," said the Prince, "you've just come in the very nick of time, for tomorrow is to be our wedding-day; but now I won't have the Long-nose, and you are the only woman in the world who can set me free. I'll say I want to see what my wife is fit for, and beg her to wash the shirt which has the three spots of tallow on it; she'll say yes, for she doesn't know 'tis you who put them there; but that's a work only for Christian folk, and not for such a pack of Trolls, and so I'll say that I won't have any other for my bride than the woman who can wash them out, and ask you to do it."

So there was great joy and love between them all that night. But next day, when the wedding was to be, the Prince said: "First of all, I'd like to see what my bride is fit for."

"Yes!" said the step-mother, with all her heart.

"Well," said the Prince, "I've got a fine shirt which I'd like for my wedding shirt, but somehow or other it has got three spots of tallow on it, which I must have washed out; and I have sworn never to take any other bride than the woman who's able to do that. If she can't, she's not worth having."

Well, that was no great thing they said, so they agreed, and she with the long nose began to wash away as hard as she could, but the more she rubbed and scrubbed, the bigger the spots grew.

"Ah!" said the old hag, her mother, "you can't wash; let me try."

But she hadn't long taken the shirt in hand before it got far worse than ever, and with all her rubbing, and wringing, and scrubbing, the spots grew bigger and blacker, and the darker and uglier was the shirt.

Then all the other Trolls began to wash, but the longer it lasted, the blacker and uglier the shirt grew, till at last it was as black all over as if it had been up the chimney.

"Ah!" said the Prince, "you're none of you worth a straw; you can't wash. Why there, outside, sits a beggar lassie, I'll be bound she knows how to wash better than the whole lot of you. Come in, Lassie!" he shouted.

Well, in she came.

"Can you wash this shirt clean, lassie you?" said he.

"I don't know," she said, "but I think I can."

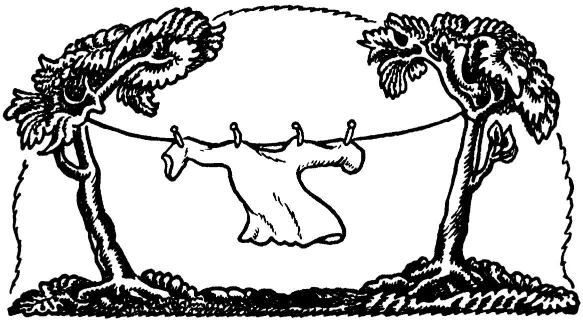
And almost before she had taken it and dipped it in the water, it was as white as snow, and whiter still.

"Yes; you are the lassie for me," said the Prince.

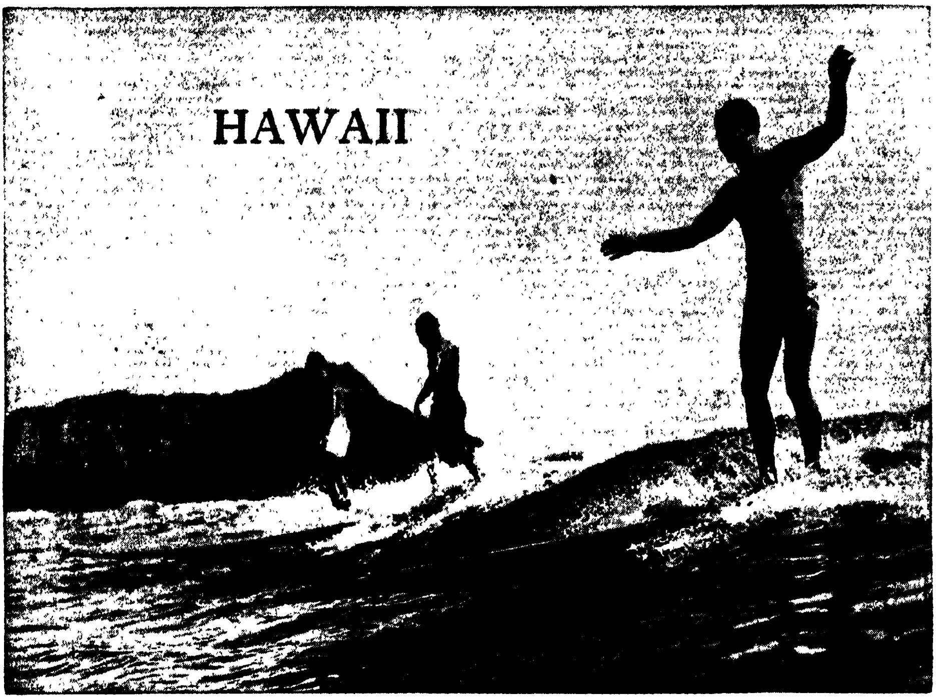
At that the old hag flew into such a rage, she burst, and the Princess with the long nose after her, and the whole pack of Trolls after her—at least I've never heard a word about them since.

As for the Prince and Princess, they set free all the poor Christian folk who had been carried off and shut up there; and they took with them all the silver and gold, and flitted away as far as they could from the castle of the Trolls that lay East of the Sun and West of the Moon.

THE NEXT STORIES ARE ON PAGE 5528.



HAWAII



Philip Gendreau, N. Y.

With spray flying, a breaker carries these skillful surf-riders into shore at Waikiki Beach.

EVERY year many people visit the Hawaiian Islands, so we shall here describe the eight principal islands which form this territory of the United States. Some scientists say that the island of Hawaii is the oldest of the group raised in the Pacific Ocean by a volcanic upheaval when the world was young; others say that it is the youngest. Perhaps some day the geologists will be able to settle the question, but so far they have not agreed. However, this island is the largest of the archipelago, as a group of islands is sometimes called, and formerly it was the most important. It is most closely associated with the history of the natives, and it was the first of the group to become known to the white man. Also it gave its name to the whole territory. Lately Oahu has become the commercial and social center.

Hawaii is shaped like a rough triangle with an area of 4,030 square miles. Its surface consists mainly of the slopes of five volcanoes; and as visitors approach it they are awed by its majesty and impressive grandeur as it looms out of the blue Pacific. Unlike the other islands, it has few coral reefs along the coast, and therefore has no good harbor.

The great volcanic peaks of Hawaii are Mauna Kea, which means White Mountain, and Mauna Loa, which means Great Mountain. Mauna Kea is snow-crowned and extinct, but Mauna Loa is still very active. So, too, is Kilauea, a much smaller peak. Kilauea is the most active volcano in the world, and is celebrated for its Lake of Living Fire. The Kilauea crater is three miles across.

From Hilo, the chief city of the island, there is a splendid motor road to the edge of the crater, and for most of the way huge ferns and brilliant flowers make the journey one of great beauty. This road leads through tropical jungle, over vast lava beds, and past steaming earthquake cracks, banks of pure sulfur and tunnels bored by flowing molten lava. This part of Hawaii and part of Maui make up Hawaii National Park.

The most fertile regions are North and South Kona, on the western side, where the high mountains break the force of the trade winds. A regular rainfall and wonderfully fertile soil make this section the richest in the territory. The climate is mild and genial. Professor J. K. Goodrich, in one of his books on Hawaii, writes that the Hawaiians used to say, "People do not die in Kona; they simply shrivel up and blow away!"

Maui, the second largest island of the group, has an area of 728 square miles and lies about twenty-six miles northwest of Hawaii. It consists of two mountains connected by an isthmus. On this island is the mammoth extinct volcano Haleakala, which rises over 10,000 feet above sea level and has a crater nineteen square miles in area, the largest of its kind on the earth. Under the other peak, Puu Kukui, lies the Iao Valley, often called the Yosemite of Hawaii.

West and southwest of Maui are two small islands, Kahoolawe and Lanai, respectively 45 and 141 square miles in extent. They are covered with low mountains and are given over almost entirely to sheep raising.

Molokai, which is a few miles northwest of Maui, is larger than the two just mentioned, and has a Mauna Loa of its own. In the northern part of the island are precipices ranging in height from 1,000 to 4,000 feet. On a low peninsula jutting out to the north is a famous leper settlement.

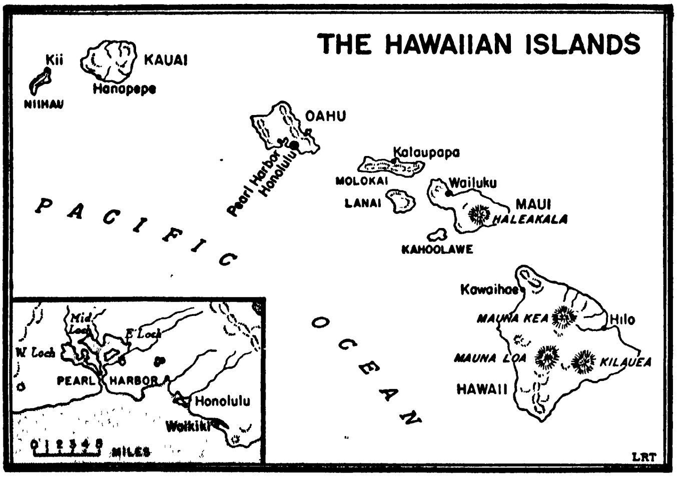
Oahu, the next in a northwesterly direction, is the most important island of the territory at present. It forms a rude square and incloses about 600 square miles of land. Toward the northeast and southwest are mountain ranges, of which the tallest peak is Mauna Kaala. Between the ranges is a plain about nine or ten miles across and twenty miles long. Oahu has the two good harbors of the archipelago, for great coral reefs lie off the coast, and breaks in these permit entrance to smooth lagoons. Pearl Harbor has been taken over by the United States Navy Department as a naval base. The other harbor gives entrance to Honolulu, the capital, a very modern and delightful city.

It is doubtful if any other city in the world has been so richly dowered as Honolulu. Before it smiles the shining Pacific as azure as the heavens above. Around it mountain and valley vie with each other in producing tropical pictures that are almost too beautiful for this world. Royal palms line the broad avenues of the city itself, and blooms of rare and startling color and size are found in all the gardens. Yet here, too, are found street cars and all the modern conveniences. The beaches, of which Waikiki is the best known, are famed for bathing, canoeing and surf-riding. There is no undertow nor are there sharks at Waikiki, for the beach is separated from the ocean by the coral reef. Even in the Hawaiian winter season the water is warm.

Near the city is the Nuuanu Valley, over

Molten lava flames and swirls in the Lake of Living Fire. This is the crater of Kilauea, one of the volcanoes on Hawaii Island.

which hangs the frowning Pali, or precipice, 1,200 feet above the sea. It was down this precipice that King Oahu's warriors flung themselves when defeated by Kamehameha toward the end of the eighteenth century. There are magnificent views to be had from the summit of the Punch Bowl, an extinct volcano, from Pacific Heights or the Tantalus. The motor drives up the Manoa Valley and around Diamond Head are very fine. There is a motor road, ninety miles in length, around the entire coast, an easy one-day trip.



This map shows the chief islands. Actually there are several other rocky islets, but they are uninhabited. The largest island of the group is Hawaii; but Oahu, on which Honolulu is situated, has become the most important.

Kauai, 555 square miles in area, lying northwest of Oahu, is a mountainous island circular in shape. It has a number of well-watered valleys which are so fruitful that it has been called the Garden Isle.

The last of the inhabited islands is Niihau, 72 miles in area. Two-thirds of Niihau is made up of a low plain formed from a coral reef covered with soil washed down from the mountains on the east coast. This island is private property, and 60,000 acres are used for stock-raising. Niihau is noted for the rush mats and the pretty shell chains made by the natives. There are scores of very small islands in the territory, but they are of little importance.

The Hawaiian Islands are known for the luxuriant tropical growth of trees and plants. The Chinese name for the group means the Sandalwood Islands, and the sandalwood tree was in great demand in China for medicinal purposes, for joss sticks, for incense and for cabinetmaking. Unfortunately, the demand almost cleared the islands of such trees. The United States Forest Service is paying much attention to the conservation and replanting of the sandalwood, and hopes to make it a valuable resource once more. On the islands of Hawaii and Maui there are large forests of koa, which give valuable lumber known as Hawaiian mahogany. Banyan, coconut, royal palms, banana and giant tree ferns are common, and the white man has introduced ironwood, blue gum and rubber.

Among the smaller plants or bushes are arrowroot, yams, sugar-cane, raspberry and Chilean strawberry and taro. Taro, or kalo, forms the principal food of the natives. The root is pounded in water until it is half liquid, and the mixture is allowed to ferment. The result is the famous poi, served in a bowl into which each person dips his fingers and skillfully catches up a mouthful. From the inner bark of the mulberry tree a fine and beautiful cloth, tapa, is woven. Another plant, ti, supplies thatching for the roofs of the houses and also a drink.

The flowers of infinite variety are unsurpassed, and charming customs are connected with them. Visitors arriving or leaving are garlanded with leis—chains of blooms—and the word of greeting is *Aloha,* meaning "welcome" or "my love to you." This word, which has become known throughout the world, is also used to mean "farewell" or "kind regards."

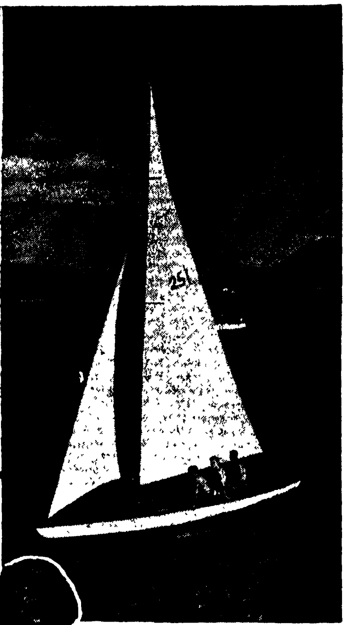
The animals native to the islands are few and unimportant, but there are many kinds of birds. The mamo is the most prized, for from it are obtained the golden feathers of which were made the war cloaks of the chiefs and kings. The purple plumage of the kahili is made into fans. Brilliant scarlet feathers from the o-o are also used for ceremonial robes. There is a curious bird, the firebird, which has a fiery red topknot, and the natives used to believe that it stole fire from heaven and introduced it in the islands.

Before the downfall of the Hawaiian kings these gorgeous birds were protected by a royal order forbidding the killing of the winged beauties that provided the material for the regal raiment. They were also protected by the ancient priests, who taught the

WHERE NATURE IS MOST KIND

Pan Pacific Press

Waikiki Beach, one of the world's most romantic playgrounds. It is between Honolulu proper and Diamond Head, the crater of an extinct volcano which stands sentinel at the harbor's east end.



Pan Pacific Press

Skimming over crystal-clear waters under sail is one of the islands' most thrilling sports.

Union Pacific Railway

The rhythm of native music—reedy, sad, but very sweet—is beaten out on a gourd drum.

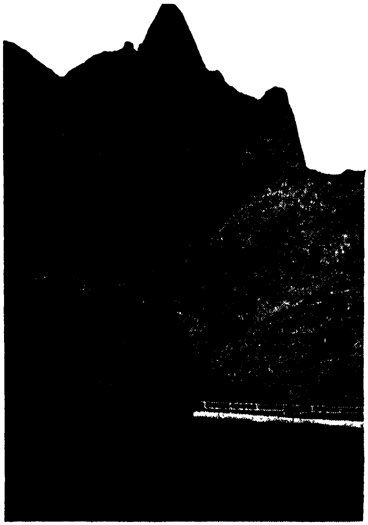
Philip Gendreau, N. Y.

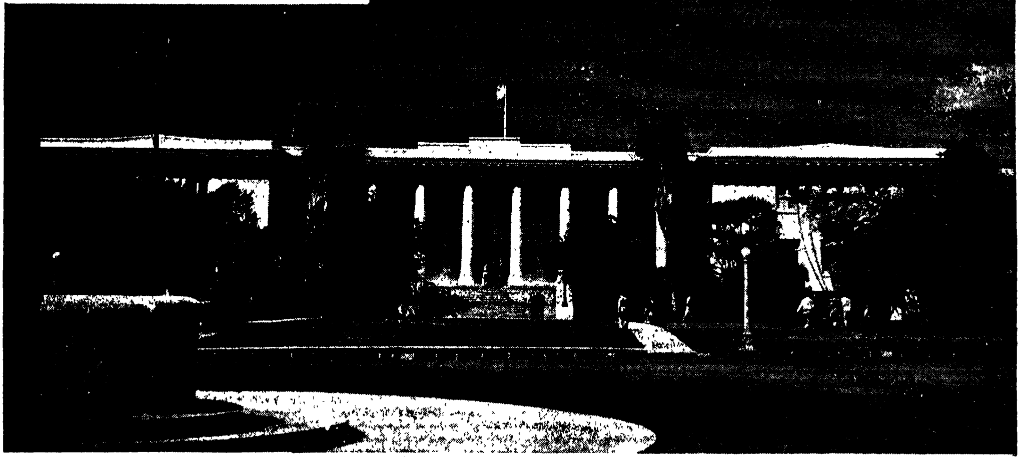
A cottage of thatch. The climate is so mild the year round that people live outdoors most of the time.

Philip Gendreau, N. Y.

Pineapple fields are seldom planted with seed. Instead, young plants, from clippings, are set through a specially treated mulch paper. This protects the plants and keeps the moisture from running off.

AT THE CROSSROADS OF THE PACIFIC





L. Green from Gendreau, N. Y.

Top left, part of the modern highway which winds along the mountainous north shore of Oahu. This section is Pali Pass.

Pan Pacific Press

Top right, Kewalo Basin, near Honolulu, is the anchorage for tiny fishing boats, which go out to sea for hundreds of miles.

Pan Pacific Press

Center, the gleaming white building of the University of Hawaii, in Honolulu. The fountain shows native design.

Right, Hawaii's Capitol, formerly the royal palace, has the only throne room found anywhere in United States territory.

natives that in the cries of the birds were borne messages from the gods. When the monarchy was abolished and the people were converted to Christianity, the brilliant feathers lost their meaning and soon came to be worn by all classes of the inhabitants. The unfortunate birds became the objects of desire of many hunters, who sold the plumage to traders or tourists. Some bird species are almost extinct now.

In the blue waters which girdle the islands and in the lagoons which pierce them are found many varieties of fish. Some of these seem like bits of rainbow, so varied in color are they. Game fish, such as swordfish, tunny, oceanic bonito and albacore, abound. Swine, cattle, sheep and horses, as well as domestic fowls, were brought in from abroad.

Almost every agricultural crop can be grown in the Hawaiian Islands, but at present sugar is the main product. Sugar-cane is native, and Captain Cook saw the natives using it for food when he discovered the islands. About a million tons of sugar are produced each year. Growing and canning pineapples is also important, and many millions of dollars' worth of canned pineapples are exported each year. Rice is another large crop. It has been found that rubber trees flourish in the territory, and the United States Government has encouraged the industry, which has increased until the output has become important. Coffee-growing was introduced by Europeans, and now there are large plantations. The cultivation of tobacco has also flourished. Banana-growing has been a feature of island agriculture, and bananas are now one of the exports. Cotton has done splendidly in certain localities.

The population is now more than 525,000 and includes many nationalities. The majority of native Hawaiians are Christians. For the children of all races there are excellent public and private schools. There is also a university. The Bishop Museum at Honolulu preserves specimens and facts connected with the life of the territory and of Polynesia in general.

We have described the Hawaiian Islands in peacetime. On the morning of December 7, 1941, over one hundred Japanese planes attacked Pearl Harbor, without any warning. Destroyed or damaged were eight of our battleships, many other ships, and further naval and military property. United States Navy and Army casualties came to over four thousand men killed, missing or wounded. War was declared, and was fought through until V-J Day, September 2, 1945, when Japan signed the terms of final surrender.

By Ewing Galloway, N. Y.

Even in the business section of Honolulu there are broad, palm-shaded streets, and glimpses of the smiling mountains.

GREATER LOVE HATH NO MAN

FATHER DAMIEN, WHO AIDED THE LEPERS

ONE day, about a hundred years ago, a boyish young priest of twenty-three sailed away from his native land, not knowing, perhaps, that he was to spend the rest of his life halfway across the world. He was a Belgian, born Joseph de Veuster, but we know him as Father Damien, for upon entering the religious life he had changed his name to Damien.

Young Father Damien's destination was the South Sea Islands, which lie in the Pacific Ocean about halfway between America and Australia. Although they had been discovered by Captain Cook in 1778, few white men had visited them for almost a century. Those who did were chiefly traders and whalers who took there some of the white man's diseases, but did not bother to give the islanders any of the good things of white civilization. The people of the islands were ignorant and superstitious; and, in following the taboos imposed by their gods, they were unbelievably cruel. If a man allowed so much as his shadow to fall upon a chief, he was speedily put to death; no woman might eat with her husband, nor might a woman touch food offered to the idols. Such were the islands to which Father Damien journeyed and where for ten years he served faithfully among the natives as a Christian missionary.

One day he heard his bishop lamenting that he had no one to send to the lepers in Molokai. "Monseigneur," said Father Damien, "I will go to Molokai to the poor lepers whose wretched state of body and soul has long made my heart bleed within me."

To go from Belgium to the savages was a great sacrifice, but to go from the savages to the lepers was a far greater one. Leprosy was at that time a loathsome disease with no known cure.

Men found that the spread of the disease could be controlled by keeping the lepers away from their fellow-men; and for several hundred years lepers in Europe were isolated, until leprosy there was all but wiped out.

Portrait by Edward Clifford

Father Damien, who crossed the world to aid the lepers.

It was still found in other parts of the world, however, in South America, and to a small extent in North America, in Asia and some of the Pacific islands. In Hawaii it had become so prevalent that it was necessary to follow the example of the European countries—sternly to isolate the unhappy lepers and send them into exile. Now this was not an easy thing to do. The Hawaiians are a very affectionate people. The lepers did not want to leave their families and friends, and those who were still healthy preferred to run the risk rather than part with loved ones. They concealed the lepers, so that the poor creatures had to be found in secret places and taken by force. To the little lowland beneath the cliff of Molokai, one by one they were taken.

Father Damien found the leper colony in a wretched condition. The lepers were living as best they could under frail roofs made of branches. They were huddled together without care, cheer or comfort. "In this place there is no law," was the slogan, and the victims urged on death by an intoxicating drink that they concocted out of the root of the herb ki growing in abundance around them.

Father Damien saw that the greatest need was water, for the people were filthy. They did not want water; certainly they would not take the trouble to fetch it on their shoulders from a distant spring. Far up in the mountains Father Damien discovered a spring, and the king and queen of Hawaii, answering his appeal, built pipes to bring water to the sufferers. They also paid for decent houses for the lepers. Thenceforth these unhappy ones were housed in clean, comfortable cottages.

In due time Sisters of Charity of the Franciscan Order came to assist Father Damien; schools were built and hospitals, where the worst victims received medical aid and care.

Occasional travelers were brave enough to visit the leper colony to encourage the noble work of Father Damien. One wrote: "The first glimpse of Kalawao might lead a stranger to pronounce it a thriving hamlet of perhaps five hundred inhabitants. Its single street is bordered by neat whitewashed cottages with numerous little gardens of bright flowers and clusters of graceful and decorative tropical trees.

"By the roadside, on the edge of the village, between it and the sea, stood a little chapel. The chapel door stood ajar; in a moment it was thrown open, and a young priest paused upon the threshold to give us welcome. His cassock was worn and faded, his hair tumbled like a schoolboy's, his hands stained and hardened by toil; but the glow of health was in his face, the buoyancy of youth in his manner; while his ringing laugh, his ready sympathy, and his inspiring magnetism told of one who in any sphere might do a noble work, and who in that which he has chosen is doing the noblest of all works. This was Father Damien, the self-exiled priest, in the midst of his flock of lepers." This is a picture of Father Damien as we like to remember him.

Robert Louis Stevenson, spending his last years in the South Sea Islands, visited the leper colony. He found that the little leper girls loved their dolls, just as other little girls do. So he wrote back to his old home in Scotland and asked his friends to send pieces of materials with which the girls might make clothing for their dolls.

To one of his friends, he wrote: "I am just home after twelve day's journey to Molokai, where I can only say that the sight of so much courage, cheerfulness and devotion strung me too high to mind the infinite pity and horror of the sights . . . I have seen sights that can not be told, and heard stories that can not be repeated: yet I never admired my poor race so much."

When Father Damien had been some ten years among the lepers, cleansing their wounds and caring for their souls, he himself contracted the disease. He was not at all disturbed. Becoming in the final sense one of his people, he rose to still greater heights of heroism. From that time on, it is said, he began his Sunday sermons with the words "We lepers."

At his death three years later, all marks of leprosy seemed to disappear, the wounds seemed healed. By his own request he was buried under the same good tree where for some nights he had slept when he first arrived in Molokai. Forty-seven years later (in 1936) his body was reverently removed from the island and brought back to his native country, Belgium, where it now rests in a beautiful shrine in the church of St. Joseph, Louvain.

THE NEXT STORY OF GOLDEN DEEDS IS ON PAGE 5735.

The American Mission to Lepers

The medical research station at Molokai, where leprosy is studied intensively to find a way of conquering it.

American Museum of Natural History
A bullfrog, whose jolly grin belies his croak.

THE WONDERFUL AMPHIBIANS

WHAT is it that first lives in water and drowns in air, next lives in air and drowns in water, then buries itself at the bottom of water and breathes nothing? That is, in a sentence, the life-story of our common frogs.

Frogs, together with toads, newts and salamanders and a few other living forms, belong to the great class of amphibians, or Amphibia. These are backboned creatures that are able to breathe both water and air, though generally at different life-stages.

Let us start our survey of this class by following the life-story of a frog. First the egg, one of a score or of hundreds laid together in a mass. The egg is contained in a protecting capsule which takes up water when the egg is laid and swells almost to the size of a pea. In it is a considerable mass of yolk and the minute life-germ. The upper part is dark-colored, and this coloring helps to keep in heat from the atmosphere and so warm the germ into life.

After about five days the egg hatches into a tadpole. A tadpole is a queer little sort of fish, with external gills, no fins and no mouth, living on the capital with which he entered the world—the unexhausted supplies of yolk from the egg. In two or three days this is absorbed and a mouth is formed with horny jaws and lips intended only for rasping. Thus armed, the tadpole scratches off nutriment from vegetation, from flesh, from anything that can be taken in the water.

Amazing changes soon follow. The outer gills fade away and new ones develop internally. The water taken in through the mouth is squeezed out through a spiracle, surrendering its oxygen in the process.

Two limbs jut out toward the rear, but they are not yet needed for progress, as the rudder-like tail serves to propel our little friend about his business. Seven, eight, nine weeks pass, great alterations taking place slowly all the time. The tadpole becomes less and less able to exist on the oxygen taken from water, and he comes more and more to the surface to take gulps of air. Lungs form before the gills have quite ceased to function, and for a short while the tadpole can breathe either water or air. The front legs appear and are thrust out of the openings that the gills first occupied.

Then comes the greatest transformation of all. The land begins to call, with promise of unknown realms to explore. In this serious crisis the tadpole ceases to feed and his jaws begin to undergo a new change. But there is a storehouse of nutriment in his big fat tail, and as we watch we see day by day that this organ diminishes. The tadpole is living on it.

At last the whole transformation is accomplished, the old horny jaws drop off, and the tadpole has gone—a tailed frog appears, as big as a button. The remnants of the tail are there and must be absorbed—then the little frog is perfect.

There is now great peril in the tail. In climbing from the water to the land little froggie has to pass over parched stretches of bank, and repeatedly one has found that the moist tail, sticking to the surface, has sealed down its little owner and fixed it there to die, dried up in the pitiless sunshine. Therefore, whereas a great tail may give a tadpole a richer store of food in the water than a small-tailed tadpole has, a baby frog which comes out of the water with too much tail left may never gain freedom ashore.

All these astonishing events are covered by the three months of spring. When full summer comes, the frog hides by day in damp places, and splashes for safety into rushy waters when pressed. But it can no longer live in the water. Its food—insects, worms and slugs—are found on land, and the frog must now have abundant air to breathe.

When autumn gives place to winter our cold-blooded little friend must betake himself again to his cradle. He plunges into the water, dives down into the mud at the bottom, falls asleep and rests there, the living image of a drowned frog. He bobs up serenely in the spring, and the water seems to boil with his activity and ardor.

That is the life-story, in brief, of any of our common American frogs. The bullfrog, a tremendously long-lived animal, takes longer to reach maturity; it requires three years to pass from the larval stage to the perfect. Some other frog tadpoles may have to wait for a second summer before they can make the great transition, if food is scarce.

Frogs and toads have much in common, yet there are notable differences. The toad is shorter of limb than the frog, and, instead of leaping, he sometimes crawls. And whereas the frog must keep in a moist environment, the toad is formed so that he can carry sufficient moisture within his skin to enable him to live for great periods while he is apparently fasting.

The common green frog of our ponds and streams.

Both photos, American Museum of Natural History

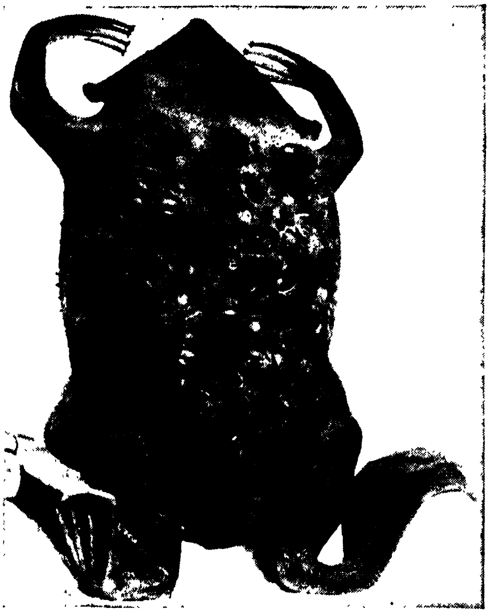
Odd spots decorate the skin of the pickerel frog.

Sucker discs on the toes of tree frogs help them to grip the leaves and bark of their airy homes.

This thought leads to the legends running through literature concerning toads having survived alive sealed up in rocks and coal for ages. There is not a word of truth in these reports. Toads may have been in rocks a few months, possibly years, but if so they have crawled there when tiny, have lived on insects that have crept into their retreats, and have grown too fat to escape from their prison.

There are multitudes of species of toads and frogs. South America has a toad over eight inches long and weighing over one and one-half pounds; but Africa has one an inch and a half larger than that—a toad that eats several mice and similar creatures at a single meal. The American bullfrog is also a monster.

At the other end of the scale is a dwarf Argentine toad only an inch long, which pipes and twitters in the love season like a



American Museum of Natural History
Baby toads hatching on the back of a Surinam toad.

goldfinch. The nest may be in a tree trunk, in leaves drawn together by the cunning of the parents, or in the hollows of rocks. A frog of the Solomon Islands has no tadpole stage. It passes through all its changes in the egg and comes forth a tiny frog ready to face the world.

One of the male frogs takes the eggs as they are laid by the female, wraps them about his hind legs and carries them with him till they hatch. He hides by day in some moist hollow in the bank of a pond, and only when his little ones are ready to emerge as tadpoles does he go into the water.

Stranger still is the nursery habit of the Surinam toad. The eggs are squeezed out by the male and spread in a layer over the back of the female. At this season the skin on the back of the female is abnormally thick and soft, and the eggs are retained by it like magic, and then quickly overgrown. Each egg has its own little cell on the back of the living incubator. The eggs may number from 60 to 120; and there they lie for three months. In that time all the necessary stages are passed through, and the mother is carrying a whole population of little toads on her back.

Then there is the dainty cradle of certain tree frogs. Here the parents hold together the edges of leaves, or double one large leaf into a cup, and in such a receptacle the mother lays her eggs, the glutinous nature of which serves to hold the side of the leaf-cradle in position. Tadpoles come forth from this cradle in the tree, slip down into the water, and undergo transformation there.

Froth safely houses the eggs of a West African and a Brazilian tree frog, whose tadpoles have to complete their change in their castles of foam, for they die if immersed in water!

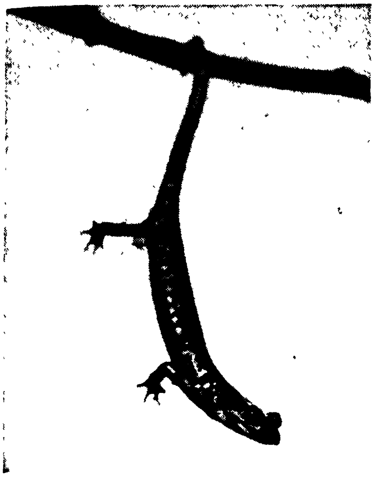
One other strange case should be noted, the most startling of all. This is a Chilean frog named after Darwin. Dangers must long have threatened the career of this species, for the anxious male will not trust the precious eggs to chance, but takes them into his mouth and there hatches them after long weeks of waiting. This amazing process is brought about by a striking pouch on the male's throat; and in that pouch his young pass from egg to complete frog.

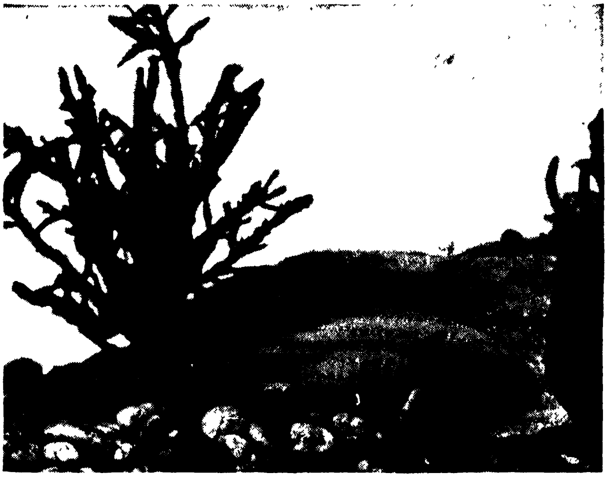
The frogs that have taken to trees have little sucker discs on the toes to give a grip on the smooth surface of the leaves. But they also possess in greater measure than any other species the power to alter their color rapidly. In changing their hue to match the general tint around them they almost rival the chameleon. Another admirable adaptation of the tree frogs is their power to sit in the scorching sun without harm.

We ought to think highly of the toads and frogs. They all eat insects harmful to us, and every garden should have its toads and frogs.

We must make our bow now to the relatives of frogs and toads, the salamanders and newts and their allies. Generally they follow the system of the typical frogs in their breeding habits, but there are important exceptions. Salamanders, newts and their allies differ from frogs and toads in that most

Vivid stripes mark the South African poison toad.
New York Zoological Society





American Museum of Natural History; New York Zoological Society

Left, a salamander that lives in trees. Right, the axolotl of Mexico, a tadpole that never grows up.

species have four limbs and full tails.

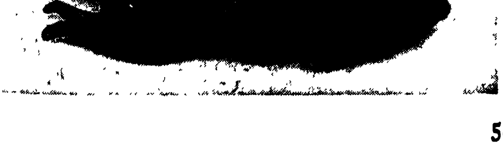
At first sight a salamander might pass for a lizard, which it closely resembles in appearance and movement, though it is less agile. Salamanders may, however, be distinguished by their smooth, damp skin. Most species are born in or near water; though with some, as, for example, the spotted salamander, the mother does not always deposit her eggs in the water, but may retain them in her body until they hatch. Even so, the young are tadpoles; and must go through their early career as water-breathers. Such a salamander may produce as many as thirty eggs or young at a time.

Our common red-backed salamander lays its eggs on land, and the young pass their entire larval life within the egg capsules as in the case of certain frogs.

The Alpine species is another that has learned to dispense with a pool for its cradle; the cradle is within the mother's own body. The adults frequent streams and moist woods high up the mountains, but the eggs are not laid in such places. Of the fifty which are retained in the mother's body only two come to life. Two perfect small Alpine salamanders come out ready to breathe air at once, and to go about their business snapping up beetles and what not.

A Western toad, which may be striped or spotted.

American Museum of Natural History



The newts are all much more fond of water, and their ability to make the best of two worlds has resulted in their spreading over a much wider surface of the earth than is the case with the salamanders. Everybody knows the newt, for there is hardly a pond or ditch without these agile creatures. Their tadpole stage is in the water, but afterward some come ashore, hide among green moisture, and only return to their pond as adults to lay their eggs.

In most respects newts are alike in habit. Their eggs are attached singly to water plants, the leaves being folded together by the hind legs of the mother and held in position by the stickiness of the egg. All are carnivorous, and eat tiny worms, small slugs and other enemies of our crops.

The spectacled newt, so called from the curious appearance of its head and eyes, is found in Italy and Sardinia. The male British newt carries on his back a handsome fin-like crest, specially prominent in the breeding season.

The axolotl has become the most famous of the Amphibia. It is a native of Mexico and many parts of North America. In

Mexico, in waters abundant with food, the axolotl swims at ease, a tadpole with true gills, and declines to take the plunge into maturity. It is born a tadpole, it lives a tadpole, and it becomes the parent of other axolotls..

It is not so elsewhere, for outside this Mexican area the axolotl changes into a well-known salamander, the *Ambystoma.* The axolotl does not remain a child merely because it is too lazy to leave its childhood waters. Something has gone wrong with the mechanism that produces metamorphosis. If this deficiency is replaced by thyroid feeding it will promptly metamorphose. The thyroid is the gland of internal secretion that produces metamorphosis. If thyroid substances are placed in the tank with frog tadpoles, they do the same, rushing the little tadpole in haste through its cycle and turning it into a frog—not of normal size, but no bigger than a fly!

There are many other interesting salamanders, some of which, dwelling in caves and deep wells, retain their gills and tadpole condition throughout life. There is a true giant of salamanders, native of China and Japan, nearly four feet long and heavy in build. Another is remarkable for having but three toes to each foot; and another, in the Mississippi country, retains gills with its lungs, and apparently lives on fish as well as worms and other fresh-water life.

A still more curious salamander is the olm, known to science as *Proteus anguinus.* It is a creature of mystery, ten inches long, with the two pairs of limbs far apart, with the eyes completely covered with skin and sightless, though still sensitive to light. Throughout life it retains its gills and remains a water-breather, deep down in the subterranean streams that course through the Alps in Carniola, Dalmatia and Carinthia. Only in time of flood is it washed into the light and its presence in life made known. Once upon a time, before it took to this dismal abode of unsunned waters, the proteus must have been a normal salamander, but all efforts to make it follow the old line of development have so far been in vain.

Yet another salamander has so far strayed from the original pattern as to have only two legs. It has gills, but also an internal breathing mechanism for the use of air.

There is something snake-like about these salamanders, but we go a step farther with the caecilians, to find amphibians that have lost their limbs entirely as well as their eyes. They are worm-like in their habit of burrowing in moist soft soil. There the mother lays her eggs and coils herself round them till they hatch. The tadpoles remain in the substance of the mass of egg till they have shed their gills, when they sally forth to the water and complete their larval growth.

A great variety of these curious creatures is spread over parts of Africa, tropical Asia and South America—there are fourteen genera in all—and this wide distribution of a helpless, untraveling group has been used as evidence of the former connection of Africa and South America. That fact alone tells a tale of ancient days.

With the Amphibia we say farewell to all the backboned life ashore.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5539.

New York Zoological Society

Newts, the familiar little creatures that may be found frolicking in the water on any summer day.

The Metropolitan Museum of Art, New York

William Sartain's fine painting, A CHAPTER FROM THE KORAN.

The LITERATURES *of the* EAST

THE literatures of the East are older than those of Europe and, of course, far older than those of America. They are almost equally extensive, and certainly have been the most influential in the history of the world.

On them are based all the great existing religions of mankind. The idea of immortality has its origin in the literature of ancient Egypt. Taoism, Buddhism, Brahmanism, the religion of the Parsees, Judaism, Christianity and Mohammedanism each has a sacred literature, with some part of the East as its birthplace.

Where the literatures of Europe and America excel is in the variety of their subjects and treatments, and the world-wide range of their appeal. They penetrate everywhere because they embrace everything. The educated Hindu, Japanese or Chinese, man or woman, reads the European literatures in proportion to his education. However, with the exception of the Hebrew literature, and in a small degree the Mohammedan Koran, which is an offshoot of Hebrew literature, most people in the Western world are not very familiar with the literatures of the East.

They have been studied most thoroughly by specialists for the light they throw on the growth, changes and spread of languages and ideas; for the information they give of the history of religions; and for the glimpses they contain of distant history, early social life and moral ideas. They abound in poetry and in tales, for poetry and tales are natural to all mankind long before they have a written literature. And because the poetry and tales suit the peoples which produce them, they descend through succeeding generations to modern times. The poetry of religion, such as hymns and rules for moral guidance, has been specially passed down by priests, and makes up a large part of the ancient literatures.

All these forms of literature are plentiful in the East. They attract all students who are engaged on a history of the mental and spiritual development of mankind. Yet Eastern literatures do not contain many of the great literary masterpieces which make a powerful appeal to the world. The outstanding exception is the wonderful literature of the Hebrew people, which has been collected from the ancient records of more than a thousand years, and is now translated into nearly all languages under the general name of the Bible. In fact, the only Eastern writing that attracts widespread interest and is not Hebrew, and can be traced to a personal source, is the Koran.

The other important writings that come to us from the East—important especially for the light they throw on early language and religion—are of unknown authorship and of great antiquity. They had been long preserved in men's memories before being recorded, and have been handled by priests for centuries.

THE CHINESE WRITE FROM RIGHT TO LEFT, IN COLUMNS

The language of China belongs to the monosyllabic, or one-syllable, family. The number of its radical, or root, words is made three times as great, however, by a change of accent. As is natural in so large a country, many dialects are spoken in the different provinces, but the chief dialect, Mandarin, is the language of literature and of polite society. The Chinese language is written from right to left, in vertical columns or in horizontal lines.

Of the first classics in Chinese literature there are five books: THE BOOK OF TRANSFORMATION, containing sixty-four essays on important subjects based on figures and diagrams; THE BOOK OF HISTORY which was compiled by Confucius (551-470 B.C.), consisting of conversations between kings and their ministers on politics, history, religion, music and astronomy; THE BOOK OF RITES, a set of rules for regulating daily life; THE BOOK OF ODES, consisting of national airs, chants and odes; the SPRING and AUTUMN ANNALS of bold historical facts.

We give you one little four-verse poem, which is typical of the odes:

THE ABSENT HUSBAND

I picked and picked the mouse ears,
Nor gained one basket load;
My heart was with my husband:
I flung them on the road.

I climbed yon rugged mountain,
My ponies all broke down;
I filled my golden goblet
Long anxious thought to drown.

I climbed yon lofty ridges,
With my ponies black and bay;
I filled for me my horn cup
Long torture to allay.

I climbed yon craggy uplands,
My steeds grew weak and ill;
My footmen were exhausted:—
And here I sorrow still!

There are, besides, FOUR BOOKS, three of which—the GREAT LEARNING, the JUST MEDIUM, and the CONFUCIAN ANALECTS—were written by the disciples of Confucius; the fourth one consists of the writings of Mencius, a religious teacher and philosopher whose books breathe a spirit of freedom and independence.

The FIVE CLASSICS and FOUR BOOKS have had a tremendous influence over millions of minds and therein lies their greatest importance.

At the close of the sixth century B.C. it was ordered that various texts should be engraved in wood, printed and published. Printing reached its full development in the eleventh century, when movable types were invented—nearly five hundred years before their invention in Europe.

Books on natural philosophy are plentiful; and there are some valuable works on Chinese law, agriculture, mechanics and trades. There are many encyclopedias and several dictionaries, composed with great spirit and patience. A celebrated collection of twenty-one histories forms an unbroken record from the third century B.C. to the middle of the seventeenth century. A collection of statistics with maps and tables in two hundred and sixty volumes is called THE GENERAL GEOGRAPHY OF THE CHINESE EMPIRE, THE STATUTES OF THE REIGNING DYNASTY.

JAPAN'S WRITTEN LANGUAGE WAS ADOPTED FROM THE CHINESE

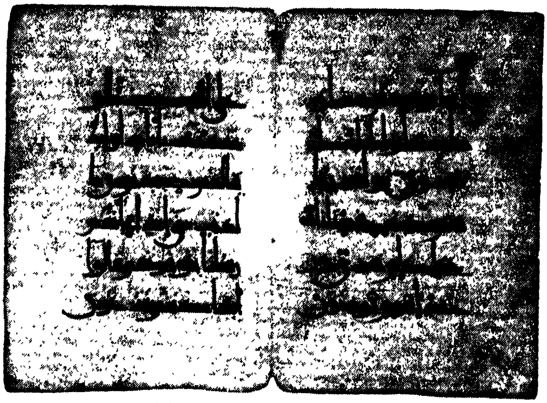
Japan adopted her written characters from China, and thus absorbed much of Chinese civilization and thought. This state of affairs lasted until the seventeenth century, when a revival of ancient Japanese traditions came about.

Japanese poetry has not suffered from foreign influence so badly. At some remote time a Japanese maker of songs discovered that a peculiar and very fascinating rhythm is produced by lines containing five syllables and seven syllables alternately. There are generally five lines to a poem, though this number is not fixed and sometimes runs to thirty or forty; but the alternation of the five and seven syllables must occur. The smallest example of it is in the *hokku,* a small complete picture containing three lines, or seventeen syllables in all. The two great masters of Japanese poetry were Hitomaro and Akahito, both of the early eighth century. Next to them stands Tsurayuki in the tenth century.

The influence of women in Japanese literature is strong. From the eighth century onward women were the guardians of the pure Japanese language, the Chinese form being adopted only by men. To this day the spoken and written language of women in Japan is simpler, softer and purer than that of the men, who use mispronounced Chinese words and employ Chinese characters in writing.

From the fourteenth to the seventeenth century is the so-called Dark Age of Japanese literature, a time when constant warfare darkened the land. It was not wholly unproductive, as it gave the drama to Japan, which in its early beginnings was a religious dance of a pantomimic nature for which the monks of Buddha composed librettos. Costumes of the utmost magnificence were worn, and mask-making became a fine art. From the somberness of these religious dances, or No, as they are called, the Japanese turned to farce, the Kyogen, or "mad-words," played in the interludes of the No. From these beginnings Japanese drama has developed into the regular theater. Though Western civilization has modified it, it has not changed its coloring. With their ability to absorb and imitate, the Japanese have been greatly influenced by Western literature.

Sanskrit is the ancient language of the Hindus, and the name means "cultivated" or "perfected." The Aryan, or Indo-European, stock had its ancient home in central Asia. From here some colonies migrated into Europe, and others through the passes of the Himalayas into India. Thus the languages of Europe and India are merely different forms of the original Aryan speech. ***Father, mother, brother, sister*** are almost the same, whether spoken on the banks of the Tiber, the Ganges or the Mississippi. In India new dialects were grafted upon Sanskrit and at length replaced it altogether, though it continued to be revered as the literary language of the country.



The Metropolitan Museum of Art, New York
Two pages from the Koran, printed in the ninth century.

A greater part of Sanskrit literature still remains in manuscript; it is nearly all composed in metre; it includes every form of knowledge except history — an important lack. The great works of Sanskrit literature correspond to the great ages of history in India. The first period covers the time when Aryan tribes speaking Sanskrit emigrated into northwestern India, where they lived as agricultural and pastoral people. To this era belong the VEDAS, or sacred books. Three of these are most important: the RIG-VEDA, containing an account of the settlement of the Aryans in the Punjab and their religion and hymns; the YAJUR-VEDA; and the SANA-VEDA. Devout Hindus acknowledge no higher authority in religion, custom and law than the VEDAS. There is, besides, a whole library of commentaries on the VEDAS, regarded as sacred books also.

In the second period the people penetrated into the fertile country between the Indus and the Ganges. Their struggles with the original inhabitants are expressed in epic poems, of which the RAMAYANA and the MAHABHARATA are the most striking and beautiful. The scope of both is greater even than that of the ILIAD and ODYSSEY.

To the third period belong the formation and development of an artistic and learned literature. Here we have collections of ancient traditions, expositions of the VEDAS and works on grammar and science.

The final period is the golden age of Sanskrit literature, when, under the rule of liberal princes, poetry and drama reached their highest points. The drama is the most interesting branch of Hindu literature. No nation except the Greek has excelled its achievement. Simple plots, purity of language, prose and verse, comedy and music unite in Hindu plays. THE MESSENGER CLOUD and SAKUNTALA of Kalidasa, the Hindu Shakespeare, are unsurpassed.

Modern literature in India consists chiefly of imitations and translations from the Sanskrit, Persian, Arabic and European languages. A modern poet, Sir Rabindranath Tagore, writing in the Bengali tongue, won the Nobel Prize for literature in 1913, and in English translations he has a large circle of European readers.

The district between the Tigris and Euphrates geographically forms one country only, though the rival kingdoms of Assyria and Babylonia became, each in turn, superior to the other. Their inscriptions, written in wedge-shaped characters, make up their literature. The key to this cuneiform inscription was discovered by an English soldier, Sir Henry Rawlinson, from some inscriptions in three languages on the face of a cliff. The Babylonians understood the movements of the heavenly bodies, and their chief work on astronomy, compiled for their great ruler Sargon is inscribed on seventy tablets. Their universities at Erech and Borsippa preserved their learning on baked-clay tablets.

THE WONDERFUL LIBRARY OF ASHURBANIPAL, ASSYRIAN MONARCH

It was in the reign of Ashurbanipal (669-626 B.C.) that Assyrian learning and art were at their height. Three great chambers in his palace piled high with records have been discovered and their contents restored and deciphered. Among them are the hymns to the gods, which are very much like the Hebrew psalms. There are, besides, two fragments of an epic written around a sun-god, THE DELUGE and the DESCENT OF ISHTAR.

Ishtar was the goddess of love, answering to the Venus of the Romans and the Aphrodite of the Greeks. The object of her descent into the infernal regions was probably narrated in another tablet, which has not been preserved, for no motive is assigned for it here. Possibly she was in search of her beloved Thammuz (Adonis), who was detained in Hades by Persephone or Proserpine.

When Ishtar arrived at the gate of Hades to the keeper of the gate a word she spoke:
"O keeper of the entrance! open thy gate!
Open thy gate! again, that I may enter!
If thou openest not thy gate, and I enter not,
I will assault the door: I will break down the gate:
I will attack the entrance: I will split open the portals:
I will raise the dead, to be the devourers of the living!
Upon the living, the dead shall prey!"

The first gate admitted her, and stopped her: there was taken off the great crown from her head.
"Keeper! do not take off from me, the great crown from my head!"
"Excuse it, Lady! for the Queen of the land commands its removal!"

The second gate admitted her, and stopped her: there were taken off the earrings of her ears.
"Keeper! do not take off from me, the earrings of my ears!"
"Excuse it, Lady! for the Queen of the land commands their removal!"

The third gate admitted her, and stopped her: there were taken off the precious stones from her head.
"Keeper! do not take off from me, the precious stones from my head!"
"Excuse it, Lady! for the Queen of the land commands their removal!"

The fourth gate admitted her, and stopped her: there were taken off the small lovely gems from her forehead.
"Keeper! do not take off from me, the small lovely gems from my forehead!"
"Excuse it, Lady! for the Queen of the land commands their removal!"

The fifth gate admitted her, and stopped her: there was taken off the central girdle of her waist.
"Keeper! do not take off from me, the central girdle from my waist!"
"Excuse it, Lady! for the Queen of the land commands its removal!"

The sixth gate admitted her, and stopped her: there were taken off the golden rings of her hands and feet.
"Keeper! do not take off from me, the golden rings of my hands and feet!"
"Excuse it, Lady! for the Queen of the land commands their removal!"

The seventh gate admitted her, and stopped her: there was taken off the last garment from her body.
"Keeper! do not take off from me, the last garment from my body!"
"Excuse it, Lady! for the Queen of the land commands its removal!"

After that mother Ishtar had descended into Hades.

We have not space here to dwell more fully on the inscriptions and clay tablets that relate the history and customs of these plain-dwellers of old. You may read about them at greater length in the chapters on Ancient Empires, The Artists of the Old Empires and The First Sculptors. There is still much to be done in the way of excavation and restoration in the "Land of Two Rivers."

Persia (Iran) has a literature extending from a remote antiquity to the present through many great changes of her language. The earliest Persian tongue, Zend, as seen in the oldest part of the sacred books of the

Zoroastrian religion, the AVESTA, still the faith of the Parsees of Bombay, was closely akin to the earliest Sanskrit. That religion symbolizes in the sun a supreme deity from whom comes all good, and it finds expression in outbursts of poetic adoration. Then Mohammedanism swept the country, left the followers of Zoroaster only a remnant, and changed the language and the national thought.

FIRDAUSI, PERSIA'S GREAT EPIC POET, AND SAADI, WRITER OF ODES

The Persian writers who had vitality enough to appeal to the world outside the Persian plateau lived after the Arab-Mohammedan conquest. Conspicuous among them is the epic poet Firdausi, whose BOOK OF KINGS, a mine of romantic story, was published in 1011 A.D. The language of Firdausi may be considered as the purest specimen of the ancient Parsee tongue. There are many episodes of great beauty in this long work. Saadi, a writer of famous odes, who has been called the nightingale of Shiraz, died in 1292. His two greatest works are BUSTAN (Tree Garden) and the GULISTAN (Rose Garden).

Greatest of all is Hafiz, the supreme lyrical writer of the Persian people, whose sweetness and melody have attracted notice from not a few poets of the West. Hafiz died in 1389. Jami, who died in 1492, has most beautifully rendered the story of Yusuf and Zulaikha. The poet best known to readers of English is Omar Khayyám, or the Tent-Maker, whose pessimistic RUBAIYAT was paraphrased in Victorian days by Edward Fitzgerald with such musical melancholy that in its English dress it outcharmed the Persian original and became an English classic. He was the Eastern poet of fatalism, preaching the text: "Let us eat and drink, for tomorrow we die." Omar Khayyam was not only a poet but a scientist as well.

It is possible that Omar was never really a tent-maker. Probably he inherited the classification from his father's trade. He lived a life of thoughtful leisure, pensioned by his sultan as the greatest astronomer and mathematician of his country and time. He lived with his own thoughts and studies and pleasures, and did not aspire to the official dignities and courtly occupations he might have had. His writings on mathematics, in Arabic, and his astronomical observations gave him such fame that in 1079, when it was deemed advisable to reform the calendar, at the beginning of what is known as the Seljuk Era, the formidable task was assigned to him. His is one of the great names of the Middle Ages.

The literature of ancient Egypt consists only of inscriptions painted or engraved on monuments, or of manuscripts written on papyrus (parchment made from reeds) buried in the tombs or beneath the ruins of temples. Though the language and the written characters of the Egyptians changed through the centuries, yet their literature remained the same in its principal features. In the great period of Rameses II, novels or works of amusement were the chief forms of literature; under the Ptolemies, historical records; and in the Coptic period, homilies or church rituals.

The Egyptian priests from earliest times kept the annals of their country, but these were all destroyed by the conquering Cambyses (500 B.C.). They were rewritten, however, and important fragments have been unearthed. The historical papyri that have been found are records of kings, or accounts of contemporary events pictured on monuments.

Of the religious literature the most important which survives is the BOOK OF THE DEAD, a funeral ritual containing prayers, an account of the adventures of the soul after death, and directions for reaching the Hall of Osiris—the abode of departed spirits. In the chapters on the history and architecture of Egypt you can read more about the beliefs of the ancient Egyptians.

We have about eighty letters on various subjects, dating from the time of Rameses II, which give us a good idea of the style and manners of that age. In fiction there is THE TALE OF TWO BROTHERS and THE ROMANCE OF SETNA. There are some remarkable medical papyri also.

The famous Library and School of Alexandria belong to a time when Egypt had passed under the influence of Greece; they are not Egyptian in thought or feeling.

THE DEBT WE OWE TO ARABIC SCHOLARS AND SAGES

The language in which, apart from the Hebrew, the East has spoken to the world (of course by translations) is the Arabic. There was a time, during the Dark Ages of Europe, when the most learned books in the world were being written in Arabic. The practice of medicine, for instance, was governed for five hundred years by the writings of Avicenna, a Persian born at Bukhara in 980, who wrote all his books except one in Arabic; and the Spanish Moor, Averroës, born at Córdoba in 1126, influenced greatly the thought of all the Christian world by introducing afresh to its notice Aristotle's system of philosophy. These are examples of literature once world-wide in its power, but now known only to the special student.

An Arabic book that still has a wide circulation throughout the civilized world is The Thousand Nights and One Night. This treasury of romance and adventure which illustrates the Eastern custom of story-telling is now pruned and altered so as to be an amusement for children, who know it as The Arabian Nights' Entertainments. It has no known author, but is a collection of tales from many sources in lands where the spoken story is the commonest form of amusement. The story of Aladdin's lamp is from The Arabian Nights.

The book of books in Arabic throughout the whole of the Mohammedan world of over two hundred million believers is the Koran. It may be questioned whether any other book in the world is as well known by as many people as is the Koran. More probably know the Bible in some degree, but what they know of it is usually not known as well as pious Mohammedans know the Koran.

No other book claims to have a similar origin in as simple a manner. Mohammed was a religious leader with the most intense belief in his own inspiration. Whether he could read or write is doubtful. When he began his mission, knowledge of Christianity and the Jewish Scriptures had been spreading in the East for over five and a half centuries. His knowledge of them was probably gained by hearsay, as was then customary in the East with all forms of knowledge. The Arabs generally were superstitious idolaters. Mohammed was deeply impressed by the Jewish belief in One God, and he had heard of prophets who proclaimed with fervor that idea. To a similar proclamation he devoted his life, believing he was inspired from heaven as other prophets had been.

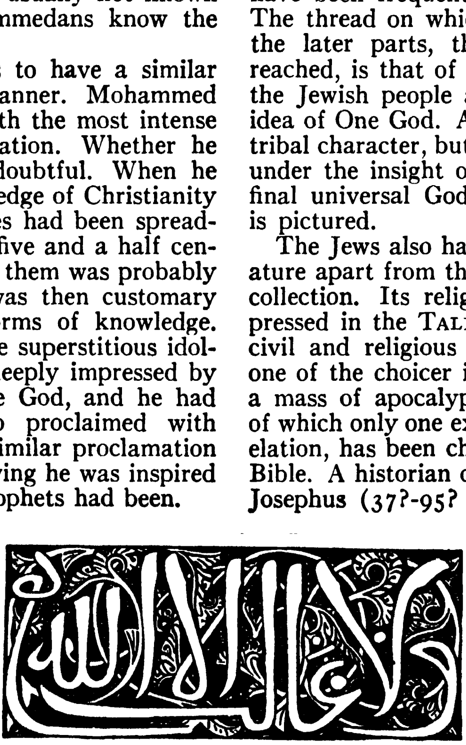
He imagined the Almighty Creator as great and remote, but all-merciful and compassionate, and that an angel came down to him from time to time to tell him the Divine Will, and to guide his conduct.

The message given in these angelic visitations he at once dictated to an attendant scribe, who wrote them down on any writing material he had at hand. These messages, continuing for years and covering many of the practical affairs of Arab life, as well as religious exhortations, formed the Koran when they were finally collected. For his book, therefore, it is claimed that it is a direct revelation to a single prophet, and it is regarded by the devout Moslem as an all-sufficient guide.

Viewed as a piece of literature produced in strange circumstances, often in the midst of dangers, by an ignorant but inspired man, the Koran has no equal. It has lofty ideality, genuine poetry and true eloquence, mixed with childishness, Eastern sensuality and frequent contradictions.

The Bible, which, at a distance and through hearsay, may have prompted Mohammed to produce the Koran, is entirely different in character and origin. Instead of being one book written by one author during a continuous period, it is a collection and compilation of many writings widely separated in time and character. These writings have been frequently edited and combined. The thread on which they are strung, until the later parts, the New Testament, are reached, is that of nationality—the story of the Jewish people and their relation to the idea of One God. At first this God was of a tribal character, but the belief broadened out under the insight of the prophets, until the final universal God of the New Testament is pictured.

The Jews also have a very extensive literature apart from the writings in the Biblical collection. Its religious expositions are expressed in the Talmud, the body of Jewish civil and religious law. The Apocrypha is one of the choicer illustrations, and there is a mass of apocalyptic (prophetic) writings of which only one example, the Book of Revelation, has been chosen for inclusion in the Bible. A historian of the more modern kind, Josephus (37?-95? A.D.), may also be mentioned. He was a Jew who won the confidence of the Roman authorities, but he never abated his zeal as a sympathizer with his own people. He served in the forces against Rome, but was defeated and captured.



Arabic carving on the Alhambra, old Moorish palace in Granada, Spain. The inscription reads "There is no conqueror but God."

THE NEXT STORY OF LITERATURE IS ON PAGE 5747.

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The Hydrostat, invented by Auguste Piccard for extremely deep descents, as drawn by A. Leydenfrost.

What Is It Like under the Sea?

THE WATERS of the oceans cover about five-sevenths of the surface of our earth, and yet we know less about the inhabitants of all this liquid than we do about the creatures in a single backyard of dry land. I once had the chance of going down beneath the surface of the ocean in a steel ball, which I named the bathysphere, to a depth of 3,028 feet, which is more than half a mile.

"What is it like?" It is a different world from ours. There is nothing but absolute silence. It is cold, increasingly so as we descend. At a half mile the heat of my body kept the temperature inside the bathysphere up to 70 degrees, while outside it was 45 degrees. At greater depths the ocean reaches 28 degrees, the freezing point of salt water, but the great pressure at that depth forever prevents the formation of ice.

The pressure is terrific. At a half mile the weight of the water against the bathysphere was more than 7,000 tons, with 20 tons on each window. On each square inch the pressure was more than half a ton. This becomes more understandable when we realize that on our own bodies in air the normal pressure of the atmosphere is only 14.7 pounds to the square inch.

Finally, the depths of the sea are wholly without light. There is nothing but blackest, blackest night. Yet we can hardly call it "night" for there has never been any "day."

One of the astonishing sights of a descent into the depths of the sea is the changing play of color from a world of bright, familiar hues to a world of eternal darkness. The instant the bathysphere submerged, the golden world was gone. All about was a pale green, with sunlight slanting through it. At less than fifty feet below the surface, the red rays of the sun are too faint to be seen by the human eye, and red objects inside our steel ball appeared black.

As we went a little deeper, yellow tints began to vanish. The green took on a bluish tone, grew dimmer and more chill, while at a depth of six hundred feet the green had long since disappeared. There was only a strange, translucent blue that soon darkened to a blue that was almost black. Deeper still, as the last rays of the sun could penetrate no farther, a cold, unearthly gray gave way to total blackness. From then on down, no color existed or ever had existed except for the yellow beam of our lamp.

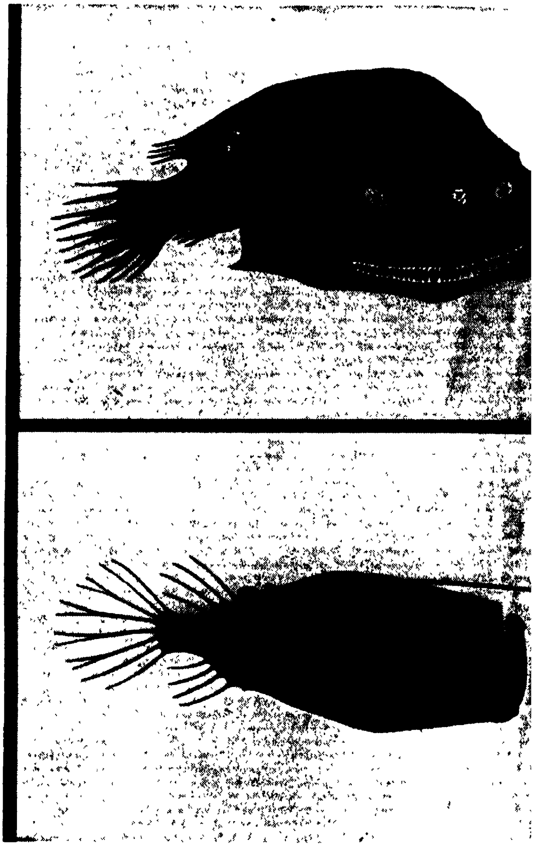
If we imagine a complete blackout in one of our cities at night, with not a single ray of light showing, we have two methods of finding our way. One is to have a flashlight or lantern and by its gleam see where we are going. A second is to feel our way by means of a cane or outstretched fingers, as a blind man must always do. The deep-sea fish have learned both of these ways. Some are furnished with brilliant head and tail lights like fireflies, or they have rows of brilliance along their sides, as if they were portholes of a ship at night. Or again, some have lantern-like affairs swinging and dangling at the tips of long tentacles. Other fish show no light, and for the most part are blind. In these the fins have grown into long feelers which are very sensitive; or tentacles may have developed many times as long as the body. With these aids the fish feel their way through life.

In these dark depths there is no seaweed, so all the fish feed upon one another or upon shrimps or minute sea life. Food is not abundant, however, and a hungry fish must be ready for any edible creature, small or large, that comes along. So we find fish with rapier teeth so long that their mouths can not be closed. Others have hinged fangs that pierce and hold the prey and then release it as it slides down their throats. Sometimes the whole jawful of teeth is luminous and must be a terrible sight to a fleeing victim. There are weird eels, black as night, each with a minute head and eyes, but a mouth many times as large as the entire body and tail. The black swallower looks like an ordinary small fish but its stomach is so elastic and the jaws so easily unhinged that it can swallow and slowly digest a fish two or three times as large as itself.

STRANGE, GLOWING CREATURES OF THE DEEP

The lesser sea folk must have means of occasional escape from their enemies or they would all be killed and eaten. So we find fish that can douse their lights at will, or blink them confusedly. Some of the large shrimps can throw about themselves, not a smoke screen, but a fire screen, a luminous fog that blinds their attacker and gives them a chance to swim off out of danger. Other creatures grow great spines and thorns.

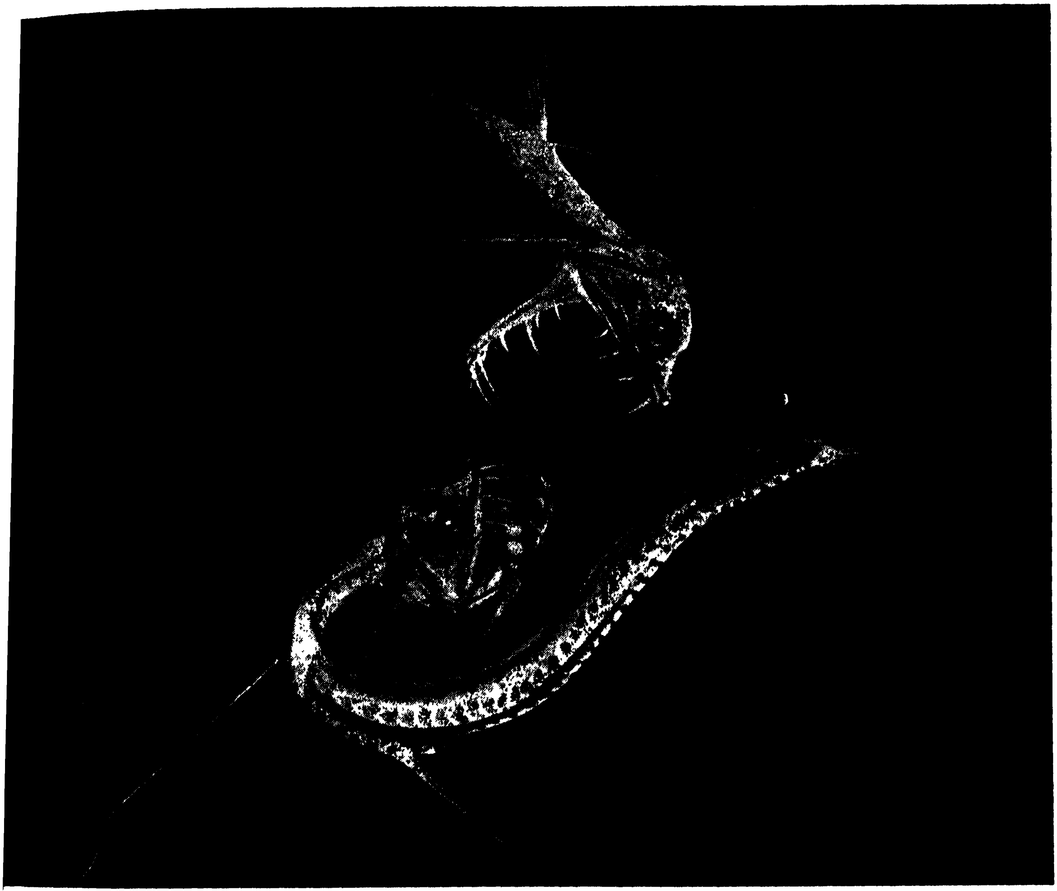
So weird and strange are the majority of abyssal—deep-sea—fish that I have sometimes played a game and nearly always won. I ask a group of friends to draw the most impossible-looking fishes they can imagine, and then I show them paintings or actual deep-sea specimens that far exceed their sketches of imaginary fish. In my nets there sometimes come up fishy sea serpents of every conceivable shape, strange heads and weaving tentacles, frightening fangs and even ablaze with colored lights—creatures that far surpass the sea serpents of myth. They lack only sufficient size, for as a rule they are four to twelve inches in length.



Drawings by Dwight Franklin

The sea devil seems to have the grin of the Cheshire cat; and the glowing wand shows in the side view.

We think of snails as creeping slowly along on log or stone, carrying their heavy houses on their slimy path. Their relatives in the deep sea have developed wings with which they fly slowly through life, not in the least bothered by their light, tissue-thin shells. There are no octopuses, but squids have run riot in the sea. Several times I have seen



William Beebe

Food is scarce in the cold depths. Here we see two baby sea dragons fighting over a deep-sea shrimp.

giants with eyes as large as dinner plates, while pigmy squids are only an inch in length. These small ones are often covered with a maze of hundreds of light organs, and by some muscular, nervous or other means can become scarlet, pale gray or blue in turn, just as neon lights are made to shift and change.

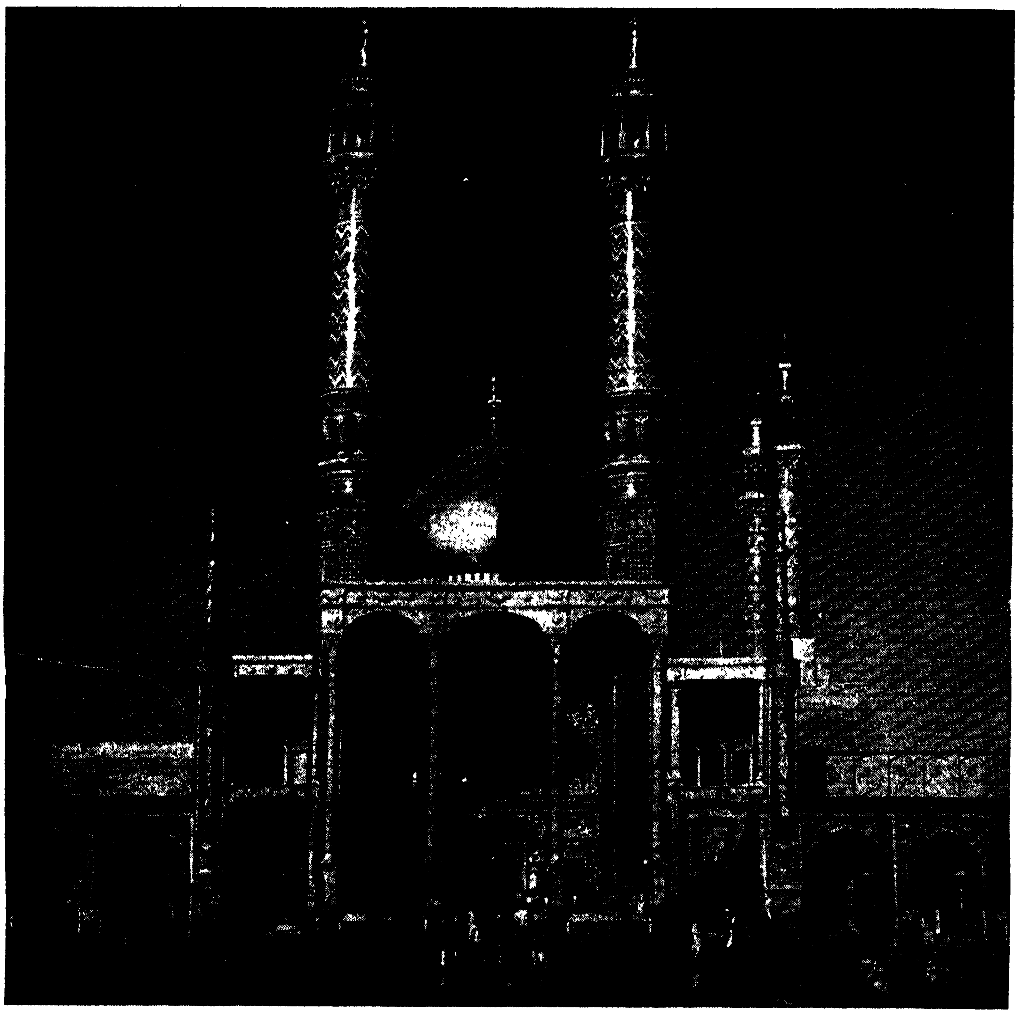
Many fish have almost no pigment and look like glass, with heart and blood visibly beating and circulating, and the courses of the last meal in full view. The hatchet fish, so named because of its shape, has rows of purple and green lights along its lower parts while its eyes are at the end of short tubes, like binoculars, pointing straight upward, so that it can never see its own illumination.

One result of eternal darkness in these great depths is to make color not only valueless, but almost non-existent. Almost all deep-sea life is either jet black or scarlet.

As one example of strange habits let us take the devil angler-fish. The female grows to a length of two feet, with a luminous bait waving on the end of a tentacle. She is covered with a black, tough, spiny skin. The males are dwarfs and are only one or two inches long. They have large nostrils and apparently find their mate by a keen sense of smell. They are numerous and hundreds start out in their search for a mate through the watery blackness. When one reaches a giant female he takes hold of her skin wherever he happens to touch, whether on head or body, and little by little the dwarf grows fast and never again swims freely. In fact he soon loses his eyes, nostrils, stomach, brain and fins and becomes a sort of parasite. Also he sets a record as the only deep-sea fish that ever finds a resting place.

By William Beebe.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5515.



Black Star

For Mohammedan worship –the exquisite Fatemeh-el Masumeh Mosque, in the town of Qum, south of Teheran, Iran.

THE EASTERN BUILDERS

DURING the first few hundred years after Christ, some wandering tribes were living in the Arabian desert without any special home. As time went on they came to be known as Saracens, which means people of the East. To them in the year 570 was born a man called Mohammed who shaped the religion that bears his name. The beliefs of Mohammed were accepted with great fervor by his people, and there grew up among them a passion to conquer the world and convert it.

These homeless desert people were natural fighters, and they carried swords sharpened by their zeal. They overran Persia, Mesopotamia, Syria, Palestine, Egypt, North Africa, Spain; they threw an outpost of their empire as far as northern India. Wherever they went they established an architecture that, though different in every country, yet had a family likeness.

In more ways than one, Saracenic architecture was a peculiar growth. The sacred book of the Mohammedans—put together by Mohammed—is the Koran. One of the laws of the Koran forbids any display of the human figure or animal forms in sculpture or painting. This restriction was the cause of the development of a brilliant geometric or fanciful ornament in flowing, fine lines, which still exists in architecture today under the name Arabesque.

The Mohammedan places of worship lacked the very heart and core of an ancient temple—the shrine where the figure of the god was set. They were simply buildings where people gathered to pray, their faces turned toward Mecca, their holy city. A little niche in the wall, called the Mihrab, indicated the direction of their city. These religious buildings—mosques, they are called —were at first very plain structures; they might be described as square spaces roofed in, where people could gather to worship. In their early history the roofs were flat; at a later date the dome appeared, generally indicating the place of a tomb.

The characteristic features of the finest Saracenic religious buildings are the pear-shaped, or pointed, domes, and the tall, strange minarets, or towers, where the priests mount at appointed hours to summon the faithful to prayer. Their greatest beauty was in the interiors, and in this they resembled the Egyptian temples, whose gaunt exteriors gave no hint of the grandeur within.

The mosque walls were decorated in every possible space. Restraint, that keynote of most great architecture, was unknown to the Saracens. They had a passion for arches, and made them as ornate as possible. They used the pointed horseshoe, the ogee (like a round arch running up in a reverse curve to a narrow point) and others even more elaborate.

THE SARACEN MOSQUE, A FOREST OF POINTED ARCHES

Arch after arch, rank on rank, as if they had been forest growths, rose up in their buildings. The richness of display, the illusion of countless lines and curves, was helped by their peculiar arrangement, which is described as stalactite vaulting. The arches that vault the ceiling ran up from the supporting pillars in a series of small pointed shapes, or niches, rising one above another, and giving a honeycomb effect. This makes a peculiarly interesting feature of the Saracenic dome.

The architects grew to have a great love for this honeycomb treatment of a surface, and used it freely as a decoration for capitals of columns, or to fill in spaces on exterior walls.

In each country they conquered, the Saracens made use of existing styles and adapted them; so that we have Egyptian Saracenic, Spanish Saracenic, Indian Saracenic and so on. There was an Eastern and a Western capital, both political and religious, of this strange, scattered dominion. One was at Bagdad, in the Persia of that day, the other at Córdoba, in Spain.

THE LOVELY TOWERS WHICH MARKED THE GRANDEUR OF THE MOORS

The phrase "the Moors in Spain" denotes the period of Saracenic rule, from about 710 to 1492. These centuries were marked by the growth of a remarkable architecture. It can not generally be called great because more attention was paid to surface decoration than to structural beauty. Yet this Saracenic spirit produced, among other things, the wonderful Giralda at Seville, one of the most beautiful towers in the world.

Every now and then the Saracens built towers like this, for no purpose at all, it would appear, save to point a finger to the glory of the Mohammedan conquerors. The minarets of the East were never as beautiful as these separate towers that arose here and there, as in Morocco and Tunis.

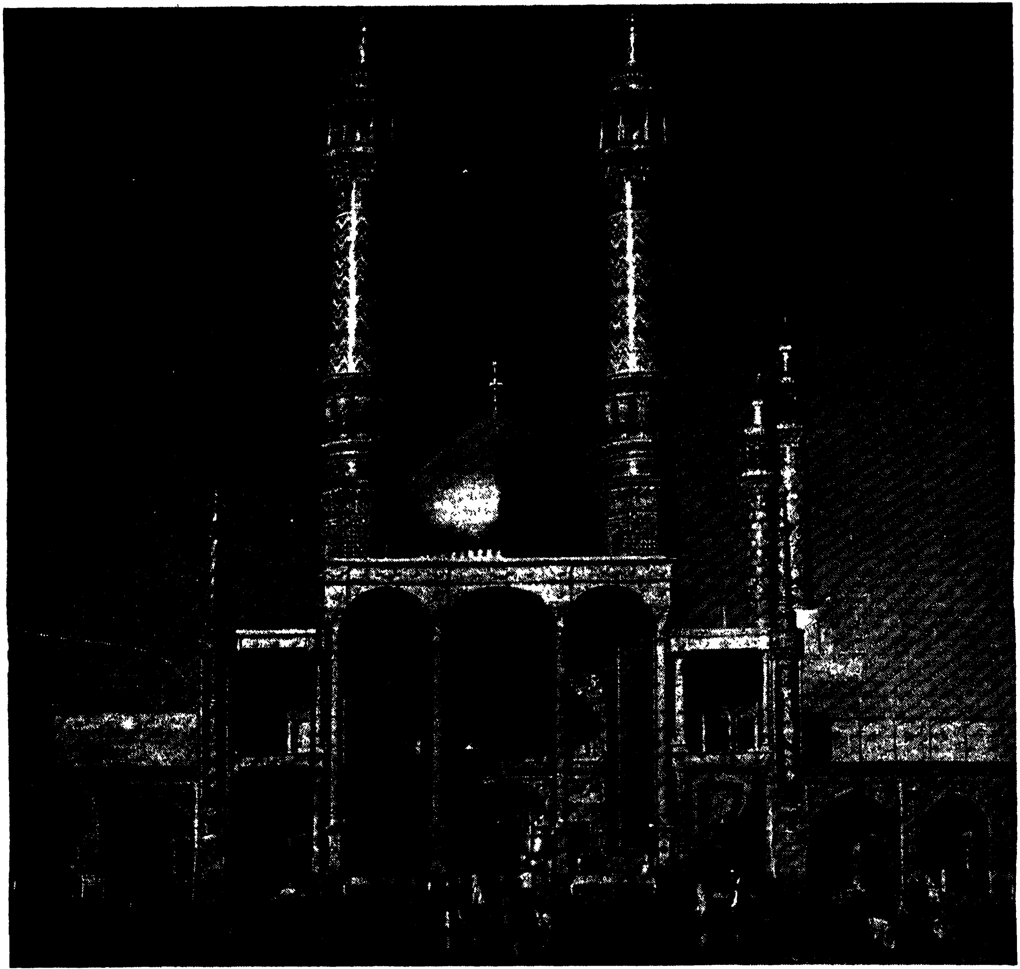
THE WONDERFUL ALHAMBRA BUILT BY THE MOORS IN SPAIN

To Spain also belongs another very famous building, the best known of all erected by the Saracens—the Alhambra, or Red Palace, at Granada. It was begun by one of the caliphs early in the fourteenth century and then was variously added to during the next two generations. The prince who planned it was a great architect and had already set up mosques in Palestine.

Like the rest of the architecture of the Mohammedan people, the Alhambra was not built so much for permanence as for lavish display. Many of its pretty arches are shams, because the weight that they should bear is really supported by lintels. The arches were merely set there to look nice. A greater sin against architectural laws could scarcely be imagined. And yet we can not but respond to the strange charm of these buildings.

Had the proud caliph of the West built less proudly and more wisely, we should not now be deploring the crumbling of his palace and the loss to the world of a singular beauty whose spirit can never be recaptured.

The Alhambra's halls and apartments clus-



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Arch after arch, rank on rank, as if they had been forest growths, rose up in their buildings. The richness of display, the illusion of countless lines and curves, was helped by their peculiar arrangement, which is described as stalactite vaulting. The arches that vault the ceiling ran up from the supporting pillars in a series of small pointed shapes, or niches, rising one above another, and giving a honeycomb effect. This makes a peculiarly interesting feature of the Saracenic dome.

The architects grew to have a great love for this honeycomb treatment of a surface, and used it freely as a decoration for capitals of columns, or to fill in spaces on exterior walls.

In each country they conquered, the Saracens made use of existing styles and adapted them; so that we have Egyptian Saracenic, Spanish Saracenic, Indian Saracenic and so on. There was an Eastern and a Western capital, both political and religious, of this strange, scattered dominion. One was at Bagdad, in the Persia of that day, the other at Córdoba, in Spain.

THE LOVELY TOWERS WHICH MARKED THE GRANDEUR OF THE MOORS

The phrase "the Moors in Spain" denotes the period of Saracenic rule, from about 710 to 1492. These centuries were marked by the growth of a remarkable architecture. It can not generally be called great because more attention was paid to surface decoration than to structural beauty. Yet this Saracenic spirit produced, among other things, the wonderful Giralda at Seville, one of the most beautiful towers in the world.

Every now and then the Saracens built towers like this, for no purpose at all, it would appear, save to point a finger to the glory of the Mohammedan conquerors. The minarets of the East were never as beautiful as these separate towers that arose here and there, as in Morocco and Tunis.

THE WONDERFUL ALHAMBRA BUILT BY THE MOORS IN SPAIN

To Spain also belongs another very famous building, the best known of all erected by the Saracens—the Alhambra, or Red Palace, at Granada. It was begun by one of the caliphs early in the fourteenth century and then was variously added to during the next two generations. The prince who planned it was a great architect and had already set up mosques in Palestine.

Like the rest of the architecture of the Mohammedan people, the Alhambra was not built so much for permanence as for lavish display. Many of its pretty arches are shams, because the weight that they should bear is really supported by lintels. The arches were merely set there to look nice. A greater sin against architectural laws could scarcely be imagined. And yet we can not but respond to the strange charm of these buildings.

Had the proud caliph of the West built less proudly and more wisely, we should not now be deploring the crumbling of his palace and the loss to the world of a singular beauty whose spirit can never be recaptured.

The Alhambra's halls and apartments cluster about two large courts, which are inclosed in ranks of arches, single and double, their pretty honeycombed shapes rising from slender columns. One of these quadrangles is called the Court of the Lions; and the other, the Court of the Fishpond.

The love of the Saracens for parallel lines of opposing colors, for the interweaving of Arabic inscriptions in the ornament of a building, for wall decoration in gold and rich tints, is very clearly shown in the Red Palace at Granada.

ROMAN AND BYZANTINE STYLES COMBINE WITH SARACENIC IN THE CÓRDOBA MOSQUE

The huge mosque at Córdoba is the finest religious building set up by the Moors in Spain—perhaps the finest mosque outside of Egypt. None of the Spanish mosques was domed. The Córdoba mosque is a remarkable building. While it is only thirty feet high, it covers an immense area. It was built five hundred years earlier than the caliph's palace, and shows the Saracens' skill in adapting their buildings to architecture already existing in the countries they conquered. Roman columns and round arches and Roman capitals were used, along with those of Saracenic design; and Byzantine mosaics paved the mosque floor. The interior of the church is especially rich in color, and was made radiant by numberless hanging lamps.

Of the mosques of varying importance, grandeur and style, which mark the path of the Mohammedan conquest, the finest are in Cairo; of these, the Kait Bey Mosque is generally considered the most beautiful. Others, whose fame is more historic and sentimental than architectural, are the Mosque-el-Aksah and the Dome of the Rock—the so-called Mosque of Omar—at Jerusalem; the Great Mosque at Mecca; and the Great Mosque at Isfahan, in Iran (Persia). Two fine mosques which bear the names of their founders, Suleiman and Ahmed, are at Istanbul (Constantinople), and are Byzantine in character, being planned in imitation of St. Sophia.

It is very interesting to note that during the Saracenic rule in Egypt some of the caliphs showed an inclination to adopt the idea of the Egyptian tomb-house. A few of their buildings afterward served as tombs.

In India also this happened, as we shall presently see. But, generally speaking, the Saracens were content to use flimsy materials that could not withstand the wear of many generations. One or two tombs proper still remain here and there in the lands the Saracen conquered. The most important is that of the Lady Zobeide, wife of the Caliph of Bagdad, Harun-al-Rashid. The tomb, an eight-sided building with a queer, pyramidal roof, was set up when Bagdad was in her glory. Harun lived from 786 to 809; and he is immortal through the glamour of THE ARABIAN NIGHTS' ENTERTAINMENTS. No one will ever forget Zobeide, whom he loved.

When the Saracens overran India, about the year 1000, they found, for the first time in their conquests, an architecture for the most part more casual, more indifferent to constructional laws than their own—an array of temples of fantastic and grotesque appearance. The architecture of early India, like that of the Saracens, stands apart from the world's story. Nowhere does it mark the scale of progress from one stage of advancement to another, as in the case of Egyptian, Greek and Roman work. And yet we can not pass this strange architecture, on which generation after generation expended its energy, without a thought for its qualities and an attempt to understand its workings.

THE "TOPES" OF INDIA, BUILT TO SHELTER THE RELICS OF BUDDHIST SAINTS

It was an architecture of religion, and is best grouped under the headings of the different faiths that have been held in India in historic times. Buddha preached his gospel in the fifth century before Christ. When, some three hundred years later, Buddhism became the religion of the various stocks who peopled India, its architecture began to develop. Relic worship became a strong power and gave rise to the great mounds called "topes," built for receiving relics of Buddhist saints. Some of these still exist, like the Sanchi Tope and others in central India—huge round masses of brickwork raised on platforms, with a processional path around them, and on the top of the mound the "tee," which contained the saint's relics.

An elaborately carved rail, which looks like stone imitating wood, runs round the sacred inclosure, with huge gateways whereon is some of the earliest picture-carving of the Indian artists. Here and there carved and inscribed columns called "lats" are set up. This early carving was of an individual nature already foreshadowing the wealth of odd decoration that was to come.

The temples of Buddhism were carved out of the solid rock in mountain-faces, and therefore have only one outer front. Through square openings and under great carved columns the worshipers passed into the gloom of the interior, in whose farthest depths was the sacred shrine. A great amount of work was spent on hewing out the roof and aisles of these gaunt places. The result is very impressive. Rows and rows of massive columns with carved capitals and surmounting sculptured forms flank the shrine. The outer wall presents a strange aspect, with its long lines of carved shapes, the familiar seated Buddha-form being endlessly repeated. An enormous opening, horseshoe-shaped, was carved out above the level of the doors, to let light into the shrine, and this gives a curious top-heavy look to the temple front.

The finest of these rock temples are at Karli, Ajanta, Ellora and Elephanta, on the Western Ghats.

TEMPLES OF GLEAMING WHITE MARBLE EXPRESS THE SPIRIT OF THE JAINS

Jainism, which was contemporary with, or earlier than, Buddhism, produced a strikingly different temple architecture. Instead of being cumbrous gloomy places carved out of the rock, the temples of the Jains are radiant white marble piles flung up on the mountain side. In northern India this architecture was the strongest, and here temple after temple arose in shining splendor.

Mount Abu was holy ground to the Jains, and there they built a cluster of these temples. The two most famous of a great array are the Dilwarra temple and that at Ranpur. On these interiors it seems that architects and sculptors set themselves to work for their own delight and without any regard to unity or proportion. The instinct for grotesque decoration was forming, and presently overgrew the architecture of India.

Outwardly, and from a distance, the Jain temples have an air of semi-classic simplicity, with their great columned porticoes and mounting shapes. Close at hand you can see how the wall spaces are endlessly carved. In the interiors—wonderful colonnaded aisles and shrines—it would seem that a host of sculptors had been turned loose, and these had carved and carved till not a square foot was without its fantasy.

This wealth of minute decoration was very pleasing to the Indian people. The spirit of Jainism fostered this lavish display, as it was essential that each temple should contain a number of idol-cells wherein was sculptured the statue of the saint to whom it was dedicated. In some cases they numbered hundreds.

Each of the twenty-four Jains, or saints, had an animal symbol which was always carved above the saint. Hence the profusion of animal forms and other mysterious symbols that fill the temples of this religion.

SCULPTURE IS LAVISHED ON THE BRAHMAN TEMPLES OF THE HINDUS

The rise of Brahmanism in turn brought its changes, and the architecture generally known as Hindu arose. The great temple, Bhuvaneswar, on the eastern coast, is sometimes called the finest building of this class. A very famous one is close by, at Puri. All over India rose the Brahman temples, each most profusely sculptured, each entailing the lifetime work of many hundreds of men. There are many styles among them, different shapes of entrances and different kinds of sanctuaries, roofs and columns. But over them all spreads the fantasy of the sculptor —the most important element in the building.

In southern India rock-hewn temples arose at a later date, of a different kind from those of the Buddhist order, in that they are completely hewn out of the rock and stand as one solid, fantastic mass. This Dravidian architecture, as we call it, seems to summarize the Indian style of decoration. Around the walls, which appear to crouch and cling together, run layer after layer of most finely wrought sculpture.

This decoration was always controlled by horizontal base lines. It is as if the sculptors began at the bottom, and when they had been all round the temple once, they cut a deep horizontal line and went on again, on the next layer, all round the temple walls, and on and on.

The horizontal effect thus obtained is very characteristic of a great part of Indian temples. The sculptors seemed to undo the architects' work. When walls and pyramidal roofs had been planned and thrown up for a great height, this effect of height was immediately destroyed by the horizontal lines of the sculpture.

THE BREATH-TAKING ARCHITECTURE OF THE GREAT MOGULS IN INDIA

The Saracen invasion brought a certain purity into this land of exuberant art, a breath of clearer air, a nobler style. When Delhi was made the capital of Mohammedan India, a new architecture arose. Probably the most famous early building in this city, which became so rich in lovely things, is the Kutab Mosque, erected at the end of the twelfth century. It is built of white marble and red sandstone blended, with domes and colonnaded courts. Within the precincts rises a huge tower known as the Kutab Minar, one of the finest the Saracens erected.

Later, in the sixteenth century, came the finest Indian Saracenic architecture, which was developing on simple and grand lines. Marble and decorative stone freely quarried in India inspired a more imposing and severe stye of building; and as the Saracens' love of exquisite finish in detail was helped by Hindu workmen, a very fine architecture was the result. Palaces, halls, mosques and tombs arose all over India.

One of the Mogul rulers, Shah Jehan, was a great architect, and found time during his stirring reign to set up certain buildings that have carried his name and fame down over the stormy centuries of Indian history. He did much to beautify Delhi, which to the Mohammedan is still Shah Jehanabad—the city of Shah Jehan. There he built the Jama Masjid, a mosque of fine proportions; and at Agra the beautiful building known as the Pearl Mosque, which is in white marble.

Shah Jehan built at Delhi one of the greatest palaces, planned in the most royal manner, the world has ever known. Only fragments of it remain. One of Shah Jehan's greatest works was the exquisite Taj Mahal, at Agra. This tomb-house, erected in honor of the wife he so loved, was the finest flower of Shah Jehan's rich imagination. It is built in perfect proportion and marvelous taste.

The Taj Mahal stands on a platform eighteen feet high and over three hundred feet square, with a minaret at each corner of the platform. From the middle of the building rises the pear-shaped dome and four small domes cluster round it, like buds around a flower. On the perfect shape of the white marble mass the Saracen artists laid their jewel-work in many colors. Marble terraces and beautifully inlaid walks lead up to it; dark sentinel trees make an exquisite contrast to its whiteness and light; the waters of Jumna River glide gently by.

WITH THE PASSING OF THE MOGULS, INDIAN ARCHITECTURE DECLINES

The days of the Great Moguls in India were marked by architecture that, within its own style, was superb; buildings like the mosque and Diwan-i-Kas at Futtehpore Sikri, and the Sikandra Tomb, erected by Akbar, the grandfather of Shah Jehan. For some time the tradition of excellent building was maintained, long after Shah Jehan followed his lovely wife to the grave. But, like all great movements, Mogul architecture, the finest expression of the Saracens in the East, topped its heights and sank. There has been nothing really great set up in India since.

THE CHINESE BUILDINGS, WHICH SEEM TO BE NEARLY ALL ROOF

The chief note of Chinese architecture is the roof treatment. When their builders wanted height they laid on roof after roof, with their peculiar upward-curling, leaf-like corners, all elaborately decorated, till they had attained the size they desired. Their palaces, like that of the emperor at Peiping (Peking); their temples, like the famous Confucian Temple of Heaven at Peiping; their towers, or pagodas; their *pai-lous,* or gateways—all depend on upward-curling eaves for character. The Chinese artists and architects seemed to be quite happy if they were given walls and shapes to decorate according to small, natural forms. They had the kind of vision that sees details constantly and is happiest when these details multiply on each other, like leaves on a tree.

THE GREAT WALL THAT STRETCHES ACROSS CHINA FOR 1,400 MILES

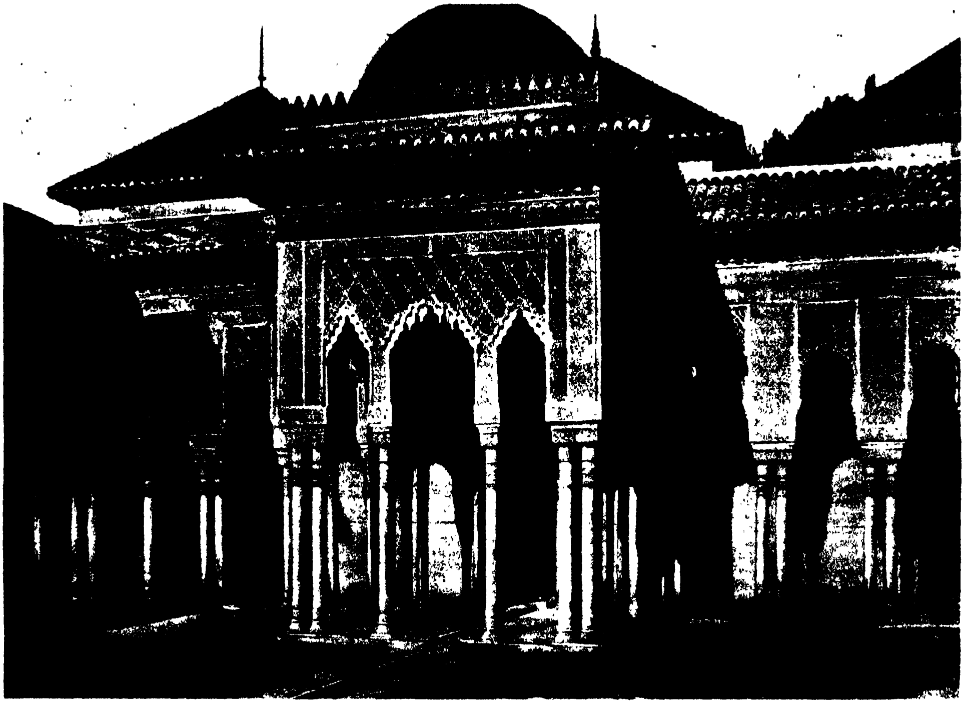
The tale architecture tells is silent during many centuries in China. Confucianism produced no great temples, as it was a code of moral laws and had no priests. And when Buddhism came in force, in the first hundred years after Christ, the Chinese, having no tradition of temples, probably could not see any reason for building them in great numbers. That they could construct when they wished we know from their bridges and from the Great Wall that, with its towers and remarkable masonry, runs up hill and down dale for some fourteen hundred miles.

The pagoda is probably the most Chinese in spirit of all the buildings of the Celestial Land. Its idea may have been borrowed from India, but its treatment is the most Chinese thing in China. It is often a memorial building, unconnected with a temple or a monastery. The commonest form is an octagonal tower with an elaborately curved roof.

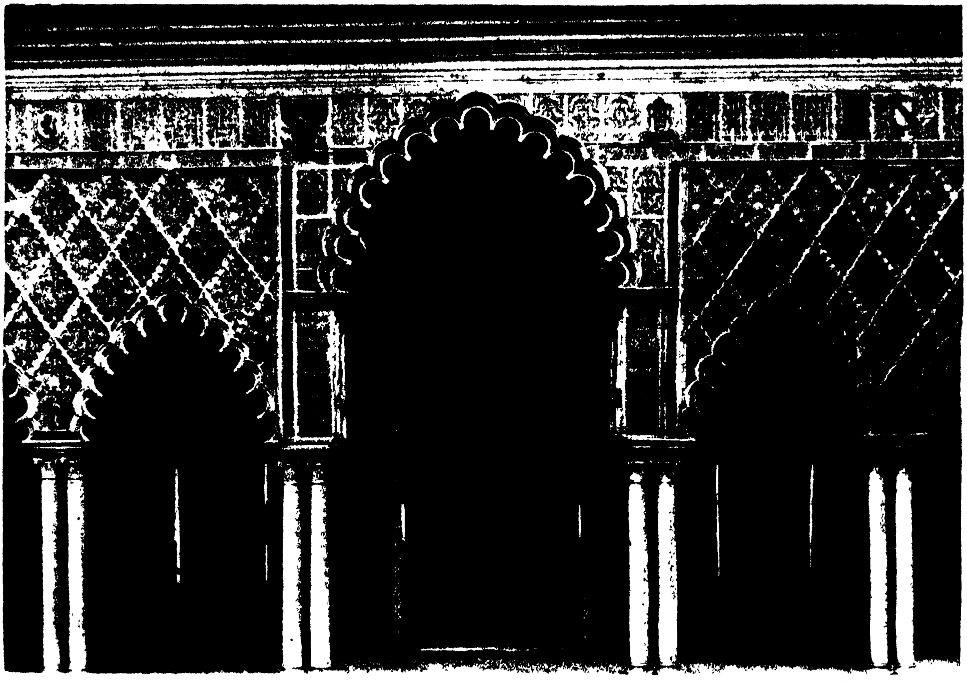
The Japanese buildings—temples, pagodas, tombs, palaces—are of the same class; a little daintier, lighter, more flower-like, as one would expect from a people living in a miniature land, who are artists in decoration based on natural forms. Although they endeavor to secure their buildings against earthquake shocks, they are never safe from destruction, as their history has told from time to time.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 5715.

TYPICAL EASTERN ARCHITECTURE



THE SPLENDID BUILDINGS LOOKING OUT ON THE COURT OF LIONS IN THE ALHAMBRA

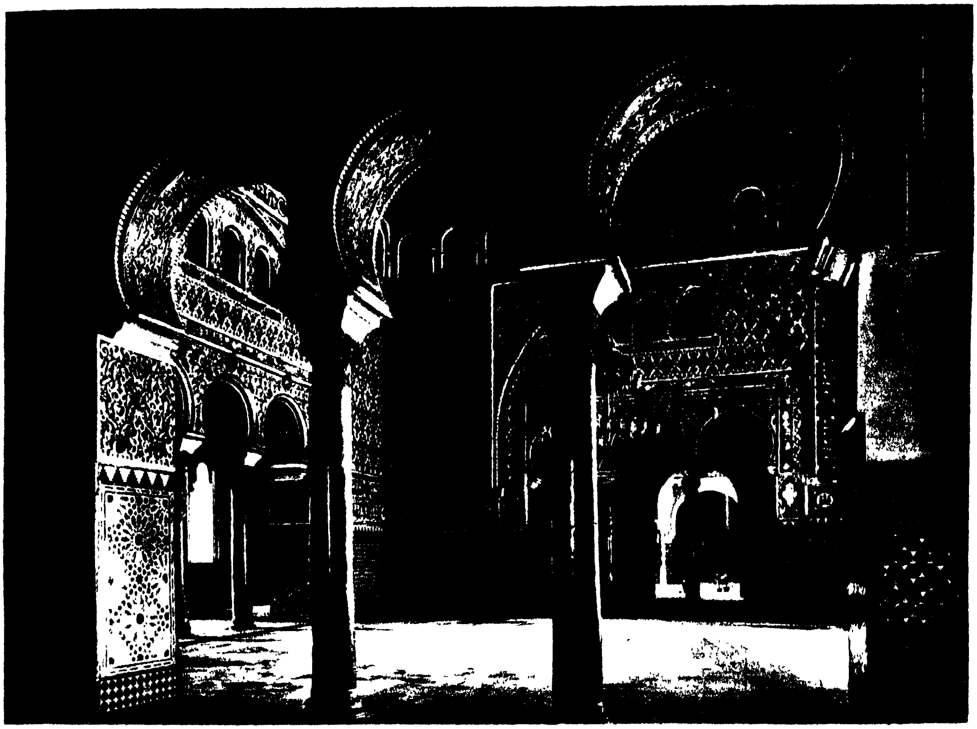


THE ENTRANCE TO THE KING'S SLEEPING APARTMENT IN THE ALCAZAR AT SEVILLE

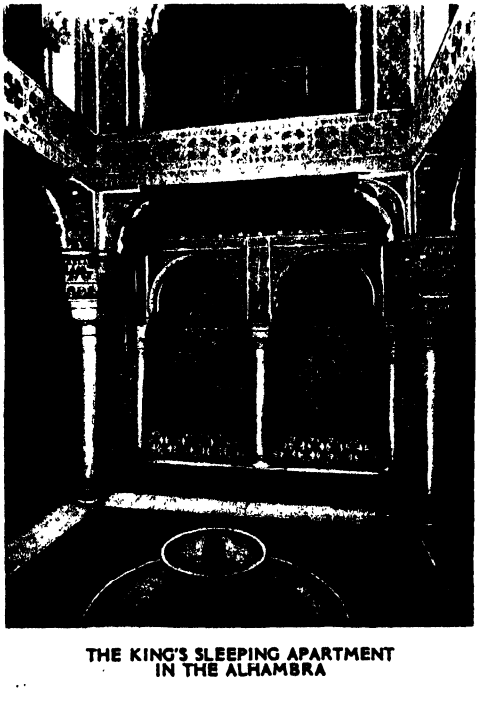
COLUMNS AND ARCHES OF THE GREAT MOSQUE AT CORDOVA

THE HALL OF THE TWO SISTERS
IN THE ALHAMBRA

ARCHES LEADING TO THE COURT OF THE
LIONS IN THE ALHAMBRA

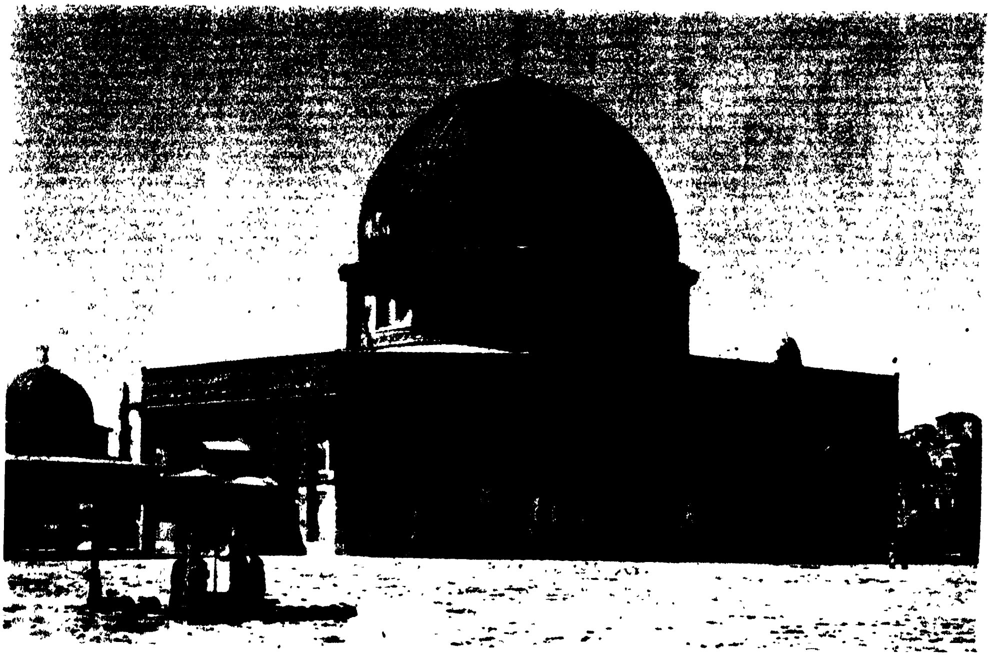


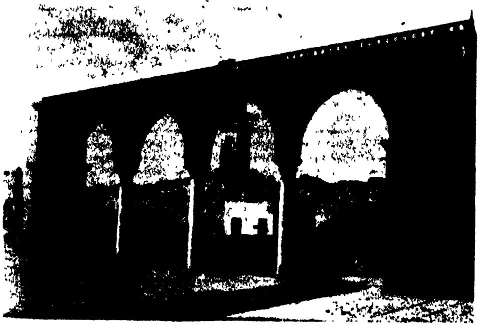
THE HALL OF THE AMBASSADORS IN THE ALCAZAR AT SEVILLE

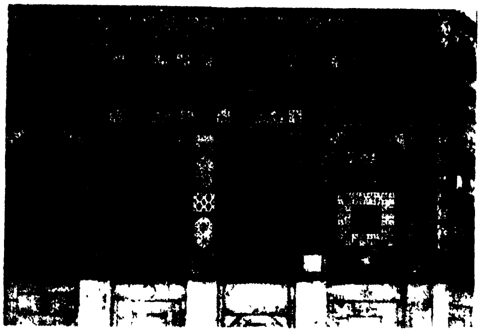


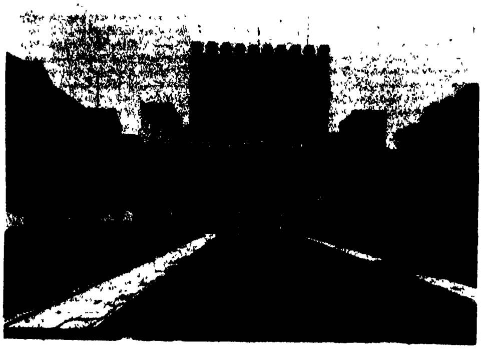
THE KING'S SLEEPING APARTMENT IN THE ALHAMBRA

A PORCH IN THE SUMMER PALACE OF THE MOORISH KINGS AT GRANADA

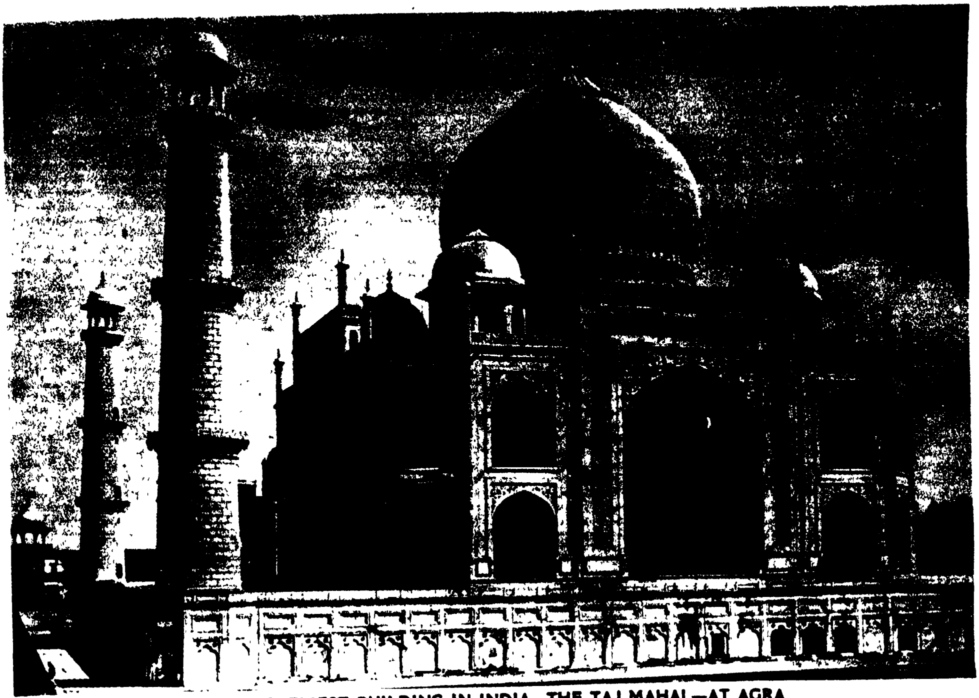

THE FAMOUS MOSQUE OF OMAR AT JERUSALEM


ARCHES IN THE INCLOSURE OF THE MOSQUE OF OMAR


BEAUTIFUL MOSAICS ON THE MOSQUE OF OMAR

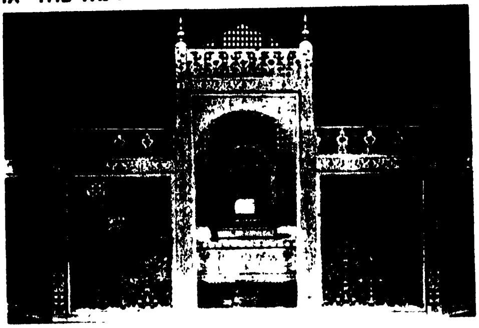

THE COURT OF THE FISH-POND IN THE ALHAMBRA

A COURTYARD IN PILATE'S HOUSE AT SEVILLE



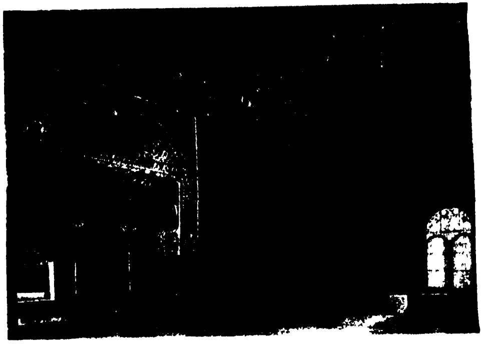
THE LOVELIEST BUILDING IN INDIA—THE TAJ MAHAL—AT AGRA

AN APARTMENT IN SHAH JEHAN'S PALACE AT DELHI

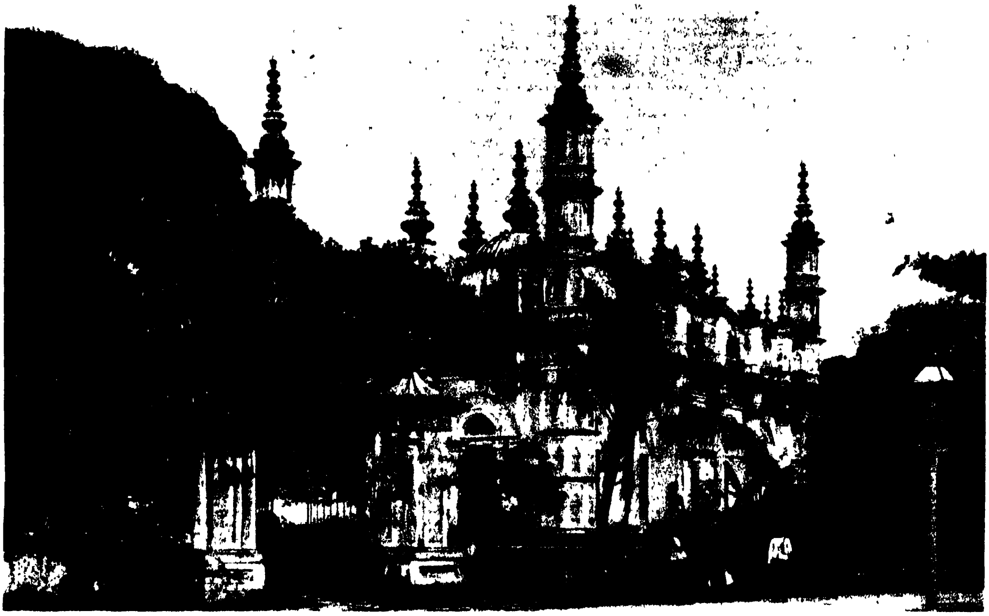


SCREEN AROUND THE TOMBS IN THE TAJ MAHAL

THE WEALTH OF CARVING INSIDE THE GREAT MOSQUE AT CORDOVA

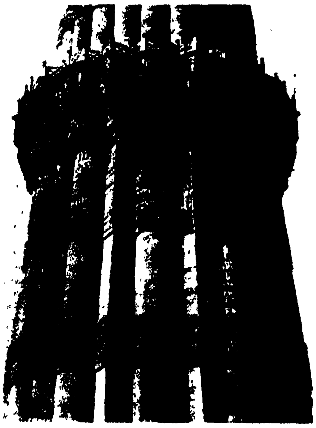


IN THE HALL OF THE AMBASSADORS IN THE ALCAZAR AT SEVILLE

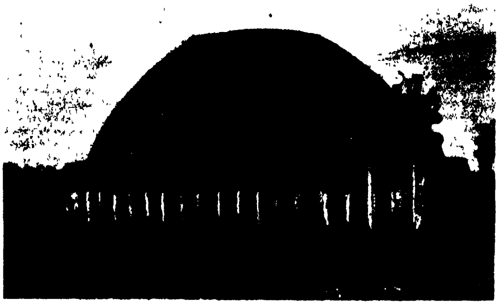

THE SPLENDID MOSQUE AT AKYAB, IN BURMA

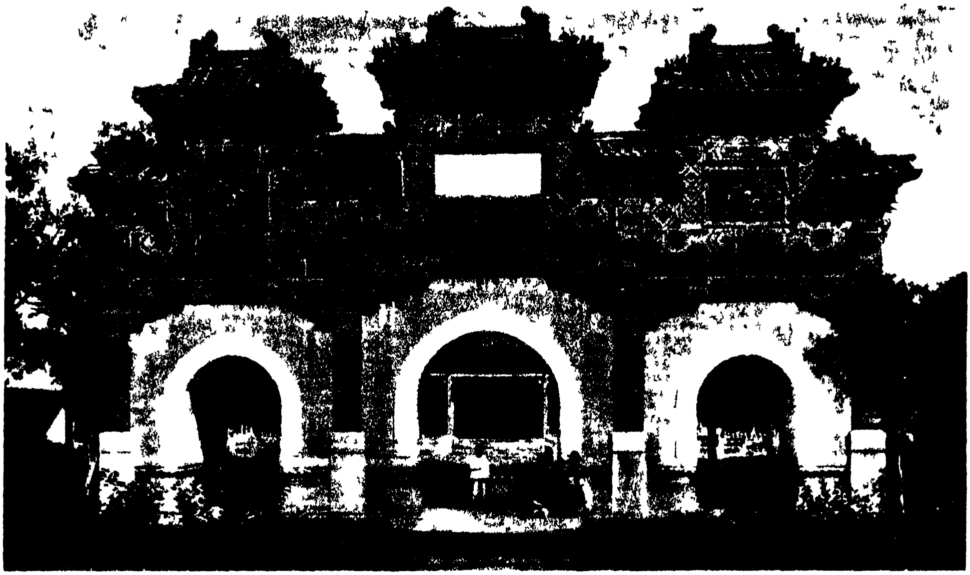
BUDDH-GAYA TEMPLE, NEAR PATNA

A ROCK TEMPLE AT ELLORA, IN INDIA

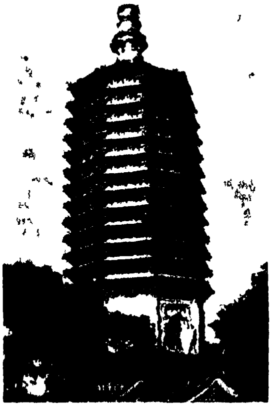

CARVING ON THE KUTAB MINAR AT DELHI

THE JAMA MASJID AT GWALIOR


THE SANCHI TOPE IN CENTRAL INDIA



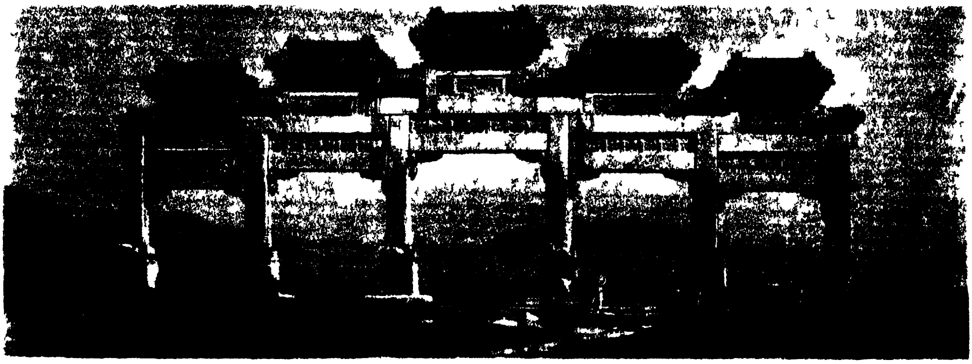
A TRIPLE ARCH IN A TEMPLE AT PEIPING



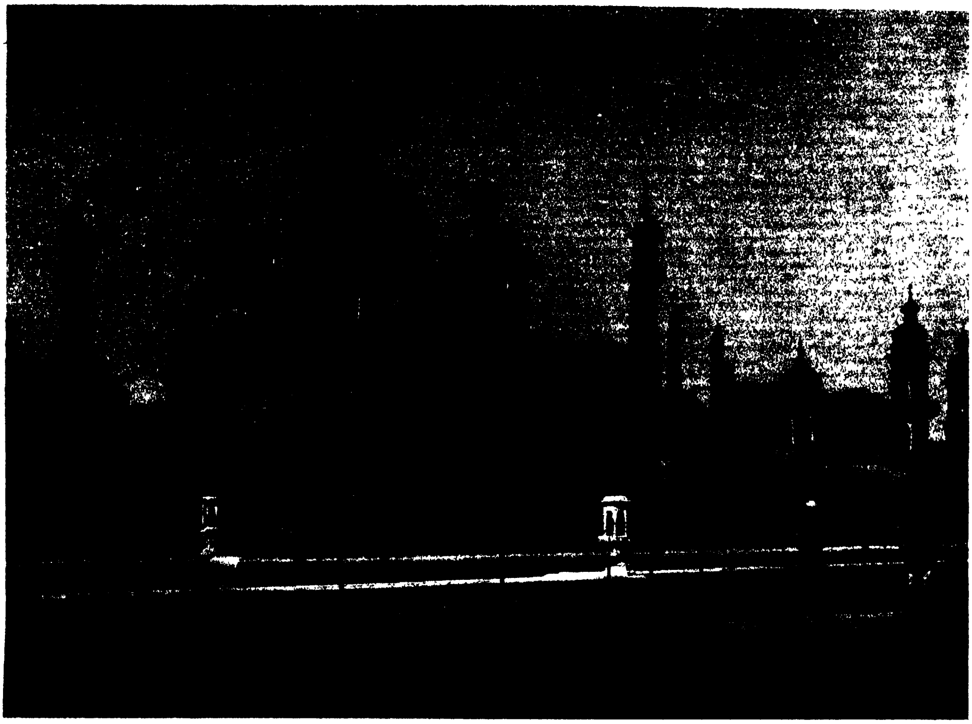
THE UMBRELLA PAGODA AT PEIPING

THE CARVED DOORWAY OF SHWEE ZEEGONG TEMPLE IN BURMA

THE LOONG WAH PAGODA NEAR SHANGHAI

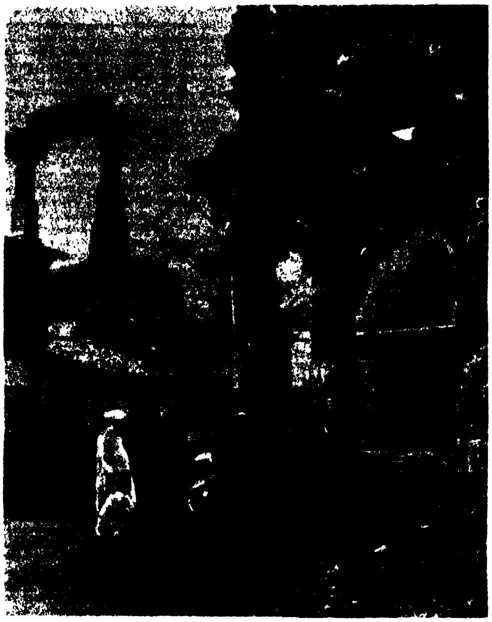


THE MARBLE ARCHES AT THE MING TOMBS IN CHINA



THE TOMB OF ZENAB ALIYA AT LUCKNOW

THE ZENANA IN FORT AGRA



A RUINED INDIAN TEMPLE AT AHMEDABAD

The pictures in these pages are by Messrs. Anderson, Bourne & Shepherd, H. G. Ponting, and others.

Painting by Dean Cornwell, courtesy, John Wyeth & Brother, Inc.

The United States Army surgeon, Major William Beaumont, using a tube to extract gastric juice from the stomach of Alexis St. Martin, a half-breed Indian trapper. At the left we see St. Martin's wife and child.

CONQUERORS OF DISEASE

WISE and learned men in all periods of the world's history have devoted their lives to the healing and prevention of disease. In ancient times, and during the Middle Ages, many useful discoveries were made about the human body and how it works, but, on the whole, progress was slow. It was not until the eighteenth century that medical science began to develop rapidly. To-day it is still growing and producing fresh miracles of healing and comfort for the human race, though there is much yet to be learned.

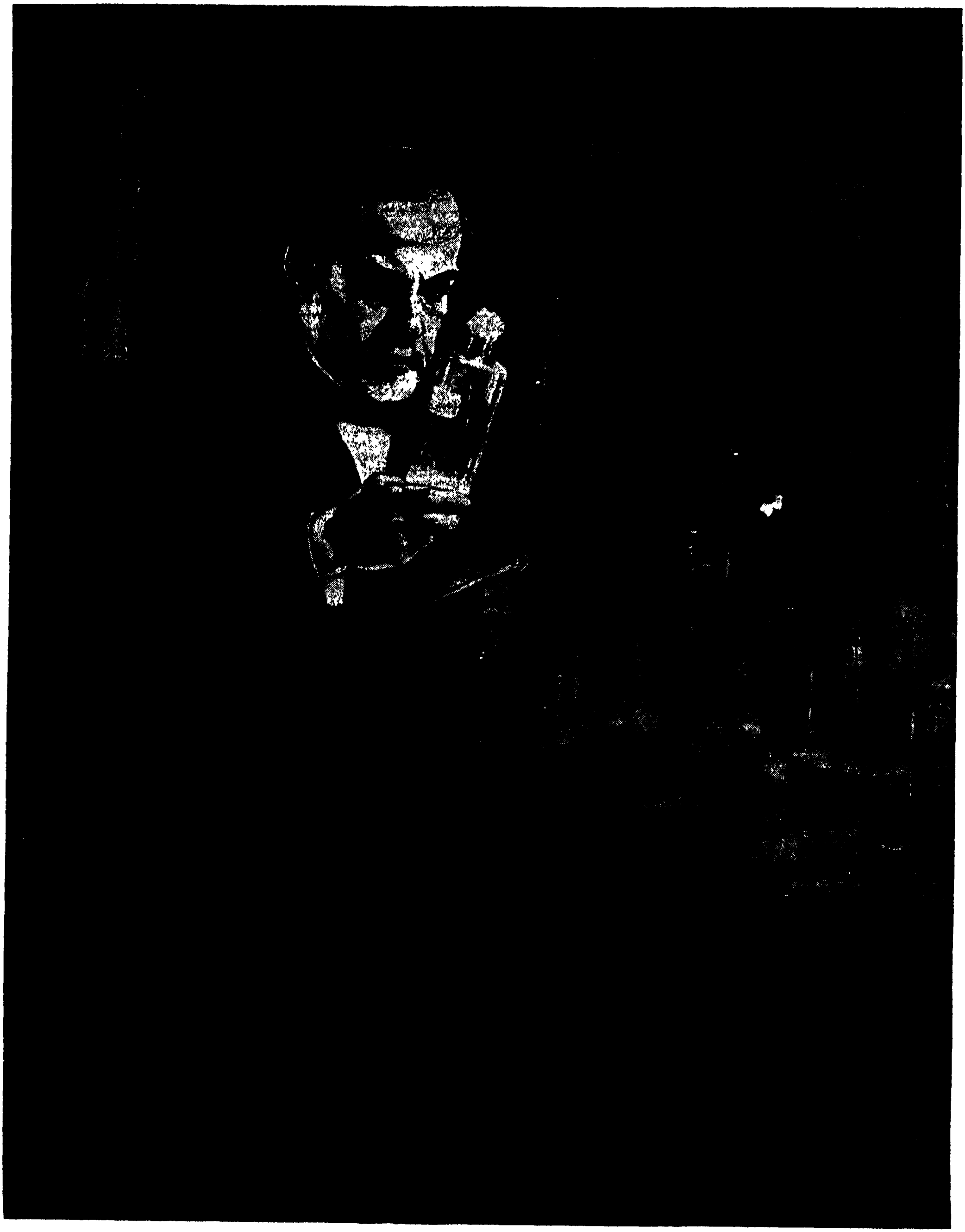
One reason why medical knowledge has made such great strides in such a short period of time is that the modern sciences of physics and chemistry have given it new tools and new methods with which to work. From the physicist have come such tools as the X-ray and the microscope, and from the chemist many new drugs and medicines, and an exact knowledge of the material of which our bodies are made. But in all ages the patience and unselfish devotion of a few men have been the foundations of all medical achievement.

In the article that begins on page 2721 we have told about some of these men, including the earliest of whom any record exists. Now we shall tell more about the outstanding conquerors of disease who lived in the nineteenth and twentieth centuries.

The first two of whom we shall speak are of especial interest to us because they were pioneers of medicine who lived in America when the continent was still largely in the pioneering stage. William Beaumont (1785-1853) was a surgeon with the United States Army during the War of 1812. In 1822, while he was stationed at Michillimackinac, he was called upon to treat a young half-breed Indian, Alexis St. Martin. A bullet had torn a hole in the man's stomach, and he was in a very serious condition. Beaumont was successful in his care of the wound and the man recovered his health, but a strange thing happened. The flesh over the wound would not join together, but healed in a sort of flap covering a small hole through which the digestive process in the stomach could be seen.

This was not very pleasant for Alexis St. Martin, but it was a wonderful thing for Dr. Beaumont, and for medical knowledge in general. St. Martin's stomach became a laboratory for the study of the action of the

LOUIS PASTEUR IN HIS LABORATORY



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Louis Pasteur, the great French chemist, was the first person to show clearly the relation between microbes and disease, and it is this basic discovery that will preserve his fame as long as our civilization lasts. For centuries men had been trying to prevent or cure the terrible infectious diseases that caused so much suffering and death. They failed because no one knew that disease could be caused by germs or microbes too small to be seen by the naked eye. Even after the microscope was invented and people could look through it and see the microbes it was not known that these creatures could cause illness. But as soon as Pasteur proved that this was so, other men were able to study the different kinds of microbes and learn how to deal with them.

stomach and its juices in digesting food. Beaumont was able to find out things that had never been known before, for this was the first time in medical history that such a condition had been made use of to see what actually happens to different foods when they reach the stomach. The observations and tests that Beaumont made were in themselves of the greatest importance, and they also showed the way for later and more scientific studies by others.

A PIONEER SURGEON WHO LIVED IN A KENTUCKY VILLAGE

The other pioneer American doctor of whom we shall tell was Ephraim McDowell (1771-1830). He was a Virginian who had studied medicine at the University of Edinburgh, which was at that time the most famous medical school in the world, and who had gone to live in Danville, Kentucky. McDowell was really a skillful surgeon, and had he lived to-day he would probably have specialized in surgery. In those days, however, and in a village like Danville, there could be no specialists. There were few doctors and these few had to be prepared to treat any and all kinds of disease and injury.

One day in 1809 Dr. McDowell found that one of his patients, Mrs. Jane Crawford, was suffering from a large tumor which, if allowed to grow, would eventually kill her. The doctor knew that the highest medical authorities had said that this kind of tumor could not be cut out without causing the patient's death. He was convinced, however, that he could remove it safely. He told Mrs. Crawford all of this, and the brave woman declared that she was willing to take the risk if he would operate. The neighbors and people of the town were very angry, however, when they heard what the doctor was going to do. They said that he was nothing but a murderer, and threatened to punish him if he performed the operation.

McDOWELL'S ACHIEVEMENT WAITED LONG FOR RECOGNITION

This did not frighten either the doctor or the patient, and the tumor was cut out. Mrs. Crawford soon got well and lived many years longer in excellent health. This was the first time such an operation had ever been performed, and when Dr. McDowell sent a brief description of it to a medical journal in the East it was thought that he was not telling the truth. Not until many years later, after he had successfully performed a number of similar operations, did the medical world recognize his achievement. To-day such operations are frequently performed, and the surgeons use much the same methods that Ephraim McDowell used.

In the days when Beaumont and McDowell were carrying on their work, little was known about the causes of infection in cuts and wounds. Nobody knew how the microbes (bacteria) that caused blood poisoning, or gangrene, got into the wound, and so nobody knew how to prevent them from getting in. That is one reason why so many patients died of gangrene after surgical operations in the days before Pasteur showed how bacteria work and Lister found a way to prevent bacterial infection.

THE CHEMIST WHO COMPLETELY CHANGED MEDICAL SCIENCE

Louis Pasteur (1822-1895) was a chemist, and one of the true benefactors of mankind. Born in the little French town of Dôle, he became interested in chemistry when he was studying at the Royal College at Besançon. When he had taken his degree in literature he began to prepare for the examination necessary to admit him to the École Normal, or normal school, in Paris. In 1847 he received his degree in physical science, that is, physics and chemistry, from the École Normal, and was appointed assistant in the laboratory at the University of Paris.

Here he made his first great discovery. A chemist named J. B. Biot had made experiments which led to new knowledge of the effect of light on the crystals of tartaric acid. Pasteur in his study of the crystals completed the discovery and finished the work that Biot had begun. The discovery was very important, and when the experiment was carried out in his presence, Biot cried out: "My dear child, I have loved science so well throughout my life that this makes my heart beat fast."

PASTEUR FINDS THE MICROBES THAT CAUSE FERMENTATION

As a result of this discovery of what he called "left-handed tartrates," Pasteur was made professor of chemistry at Strasbourg, and a few years later he was made dean and professor of science at the University of Lille. He led a busy life, for his motto was "*Travailler, travailler toujours*" — "Work, always work." Besides the many duties that a college professor has, he continued to seek the answers to many puzzling questions of science. One of these questions, why does beer turn sour? was brought to his attention by the brewers of Lille. Pasteur sought diligently for the answer. Helped by the experiments he had already made with tartaric acid and fermentation, he found that beer and wine and milk are turned sour by the action of tiny organisms (living things) called microbes, or bacteria. If these microbes were kept out of the vessels which held the liquids, the milk and wine and beer would not turn sour.

He also found out the nature of the disease attacking silkworms that had almost destroyed the great silk industry of France. He discovered the microbes that cause cholera, which was killing French poultry, and the disease called anthrax, which is fatal to sheep and cattle. Perhaps his name is most familiar to boys and girls because of the process called "pasteurizing," which makes sure that no dangerous microbes get into milk.

THE PASTEUR INSTITUTE IS FOUNDED IN PARIS

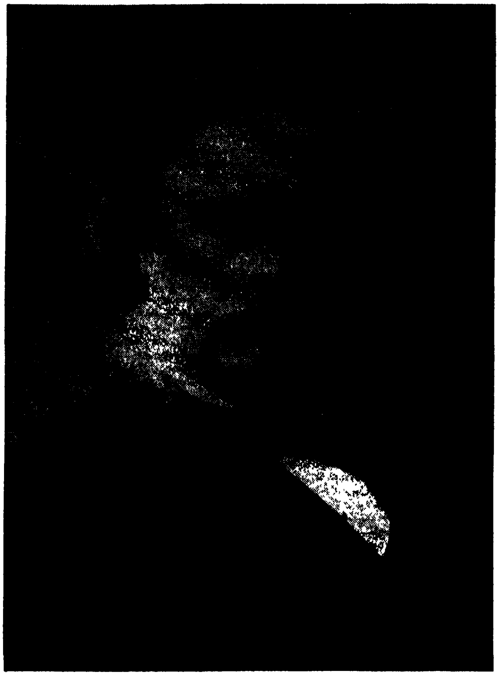
One of the most famous achievements of this great man was the prevention and treatment of rabies, or hydrophobia. Before this, the disease called rabies in dogs was a cause of terror, for the bite of a dog that is ill with rabies can cause a human being to have this terrible illness. When Pasteur made his great discovery, the Pasteur Institute was founded in Paris to study and treat the disease. The work spread to many other countries, and to-day rabies is no longer a common danger in most parts of the world.

Pasteur lived to the age of seventy-three, and when he died he was buried in the grounds of the Pasteur Institute. He was a great scientist and a devoutly religious man, who made the world safer for all of the generations of people who were to come after him.

Up to the time that Pasteur discovered the part played by microbes in the fermentation of beer, many people had believed that it might have been caused by spontaneous generation, which means that life comes suddenly into being without cause. Pasteur's discovery upset this theory, and set the whole scientific world talking. It also inspired Joseph Lister, a young surgeon, to find a means of preventing gangrene in surgical cases.

JOSEPH LISTER, WHO LED THE WAY TO MODERN HOSPITAL TREATMENT

Joseph Lister (1827-1912) was born near London, England, and was five years younger than Pasteur. His family belonged to the Society of Friends, or Quakers, and Joseph was educated at their schools and at King's College, London, where he took degrees in both medicine and surgery.



Courtesy, New York Academy of Medicine

Lord Lister, who, while still a young hospital surgeon, found out how to prevent wounds from being infected by microbes and causing the patient to die.

When he became a house surgeon in a London hospital, he was appalled by the number of deaths that came from "hospital sickness," or gangrene. At that time such a large percentage of hospital patients died of this infection that the doctors were in despair. Young Lister made every effort to improve this situation in his hospital, but except for maintaining greater cleanliness, he had made little progress when he heard of Pasteur's discovery of the microbes that cause fermentation. That gave him the clue that he needed. He had already come to believe that hospital gangrene was caused by microbes, and study with the microscope showed that he was right.

In the meantime he had gone to the hospital in Glasgow, where gangrene was raging, and he set himself to stamp it out. Pasteur's discovery taught Lister that the microbes which cause gangrene could not grow in a wound unless they had been carried there. At first he believed that they came from the air, so he looked for something that could be used to keep the air away from wounds. At first he tried using carbolic acid to form a crust over the wound. Carbolic acid is a powerful antiseptic. It kills microbes and destroys the poison that they produce, but it burns the flesh severely, and although its use permits wounds to heal without becoming infected, it leaves ugly scars. Therefore, instead of applying the acid directly to a wound, Lister began to use it as a spray. Through various steps he was lead to the belief that the use of carbolic acid was not necessary. He learned that the microbes in fresh, pure air do no harm to a wound. It was the microbes carried to the wound by the hands, the clothing, the bandages or the instruments used in an operation that did the mischief.

Thus he laid the foundation for what is called "aseptic treatment." That is, antiseptics, or microbe-destroying substances, are not put right on the wound. They are sometimes used on dressings, and they are used, as great heat is used, to sterilize, or kill the microbes, on bandages, instruments and anything else that may touch the wound.

LISTER RECEIVES MANY HONORS FOR HIS GREAT ACHIEVEMENTS

Dr. Lister became very famous for the wonderful work he did; work that made possible the safety and cleanliness of our modern hospitals and operating methods. For many years he was professor of surgery at King's College, London, and even after he retired he continued his scientific studies. He received many honors for his achievements. Queen Victoria made him Lord Lister, and he was elected president of the Royal Society, an honor that is given only to the most distinguished men of science.

The discovery of the X-rays, which also took place in the nineteenth century, also caused great changes in medicine and surgery. These rays have many uses, as you may read elsewhere, and we shall mention here only a few which have to do with the welfare of the human body. They are used to treat certain cancer-like growths and some skin diseases. By their use doctors can see broken or diseased bones through the covering of flesh, and can find out when the lungs or the stomach have been injured.

THE MAN WHO FIRST DISCOVERED THE POWERFUL X-RAYS

These wonderful rays were discovered by Wilhelm Röntgen (also spelled Roentgen) a German physicist. Röntgen was born in Prussia in 1845, and was educated in Holland and at Zurich, Switzerland, where he received his doctor's degree at the age of twenty-two. He taught at the universities of Würzburg and Strassburg, and in 1879 was made professor of physics at Würzburg. It was at this university that he made his great discovery about X-rays, or Roentgen Rays as they were called in honor of him. He died at Munich, Germany, in 1923.

DR. ROBERT KOCH CARRIES ON THE GREAT WORK OF PASTEUR

One of the greatest of the men who followed in the footsteps of Pasteur was Dr. Robert Koch (1843-1910). Born in Hanover, Germany, he studied at the University of Göttingen, and after he received his degree he went with the German army to France during the Franco-Prussian War. After the war was over he became a country doctor, but he continued to study and experiment, especially on anthrax, the cattle disease of which Pasteur had found the microbe.

Koch carried the study of this microbe on until he had learned its whole life-history, and thus taught scientists how to study all microbes. He discovered the microbes that cause cholera and tuberculosis, and found a way of preventing typhoid. After he had been made a professor in the University of Berlin, men from all over the world went to study with him, and many of his students later carried on his work. One of these, a Japanese named Kitasato, found the microbe that causes tetanus, or lockjaw, and also the microbe that causes the bubonic plague. This is the plague which visited Europe in the Middle Ages and was called the "Black Death." In Asia many millions of people have died of it throughout the centuries. Koch himself discovered a large number of important disease germs. He also worked out simple, practical methods for studying microbes, and rules which must be observed in deciding which microbe causes a disease.

KOCH IS HELPED IN HIS WORK BY THE RESEARCHES OF AN AMERICAN

Dr. Koch himself had gone to India to study the bubonic plague, and to East Africa to find out all he could about sleeping-sickness and a disease of cattle called rinderpest. He was helped in his work in typhoid and tuberculosis by the patient researches of Dr. Theobald Smith (1859-1934), an American born in Albany, New York, and educated there and at Cornell University. Dr. Smith did so many things and gave so many ideas to other men that he might be called the "scientist's scientist." For a number of years he was in Washington, carrying on research for the Department of Agriculture. He was also professor of bacteriology at George Washington (then called Columbian) University in the District of Columbia.

While he was in Washington he found out a great deal about cholera in hogs. The result of his study laid the foundation for all that Koch and other men afterward discovered about the prevention of diseases like typhoid, diphtheria and meningitis. Nowadays, people who are likely to be in places where they may be infected with these diseases are inoculated with vaccines which prevent them from getting the diseases. This treatment, which you know as vaccination, has saved many thousands of lives. You may read about inoculation elsewhere in our book. See the Index volume under the heading Vaccination.

Courtesy, Adolph Beilin, artist, and Hygeia Magazine

Dr. Robert Koch did much to establish the science of bacteriology, as the study of microbes is called.

Dr. Smith found out that the cattle tick, a harmful and very annoying pest, caused Texas fever. This was a great discovery, for it enabled other men to learn that mosquitoes are responsible for yellow fever and malaria, and the tsetse fly for sleeping-sickness. In the year of his death, he was made president of the Rockefeller Institute in New York, with which he had been associated for many years. This institution is made up of scientists who are constantly working to find out all about the human body and the enemies that attack it.

The work of Dr. Simon Flexner (1863-1946), who was director of the Rockefeller Institute for many years, is especially interesting to young people. For years he searched for the cause of poliomyelitis (infantile paralysis), and succeeded in finding the virus that causes it.

Dr. Flexner, who was born in Louisville, Kentucky, was educated at the University of Louisville medical school, and received additional degrees and honors from great institutions in many different countries. He studied the causes and treatment of a number of diseases and made valuable contributions to the science of medicine.

Another famous doctor was Elias Metchnikoff (1845-1916), a Russian Jew who was born at Kharkov, and educated there and in Germany. For many years he was professor of zoology at Odessa, then he retired in order to devote all of his time to the study of invertebrates, a branch of animal life which includes such creatures as sponges and other animals that do not have backbones. Much that Metchnikoff learned from these studies was helpful to him in his bacteriological work, and in his lifelong search for ways of prolonging human life. In 1888 Louis Pasteur invited him to work at the Pasteur Institute, and when Pasteur died, Metchnikoff was made the director of the Institute. In 1908 he was awarded the Nobel Prize in medicine for his discoveries about the work that the white cells of the blood do to protect us from disease.

THE RUSSIAN DOCTOR WHO SPENT ALL HIS EARNINGS ON HIS STUDIES

Metchnikoff was a poor man all his life because he spent most of the money he received on his scientific work, keeping back only enough to live on. Not all of his conclusions have been approved by other scientists, but the enormous value of his work has never been disputed. On his seventieth birthday he was given a golden book, signed by a number of the great scientists of the day, containing a record of the latest scientific achievements.

When Metchnikoff won the Nobel Prize, the award was divided between him and another great scientist, Dr. Paul Ehrlich (1854-1915). Dr. Ehrlich was born in Silesia and was educated at several German universities. He devoted his career to the study of chemistry in relation to medicine. He found a way to test and measure the serum that protects children against diphtheria, so that nowadays doctors can tell exactly how much is needed. His most famous discovery was, however, a drug called salvarsan, which kills the microbe known as *spirochœta pallida,* one of the most terrible destroyers of life and health.

THE INSECTS THAT SPREAD DISEASE AND DEATH

We have told how Dr. Theobald Smith's discovery that the cattle tick caused Texas fever pointed the way to the proper study of malaria and yellow fever. It was found that these two diseases, both of which have been a scourge to mankind for thousands of years, are caused by the sting of certain kinds of mosquitoes. The mosquitoes carry the fever microbe in their own bodies, and when they stick their sharp needles into human flesh, the microbes get into the bloodstream of the person who is stung. Many scientists have had a part in the search for the cause, treatment and prevention of yellow fever and malaria. It would be impossible to tell about all of these men in a single article, so we shall tell about the two men, Ronald Ross and Walter Reed, whose discoveries did most to teach people how to get rid of these plagues.

MAJOR ROSS FINDS THE MALARIA MICROBE

Major Ronald Ross (1857-1932) was a member of the British Indian medical service when, in 1892, he started to make a special study of malaria. One thing that he particularly wanted to find out was whether or not the fever was caused by mosquitoes. A number of scientists had in the past suggested that this was so, but as yet it had not been proved. Ross proved by his investigations that it was true, and he made a complete study of the life-history of these mosquitoes. He found, by examining many mosquitoes under his microscope, hour after hour and day after day, the tiny parasite inside the insect's body that carries the disease.

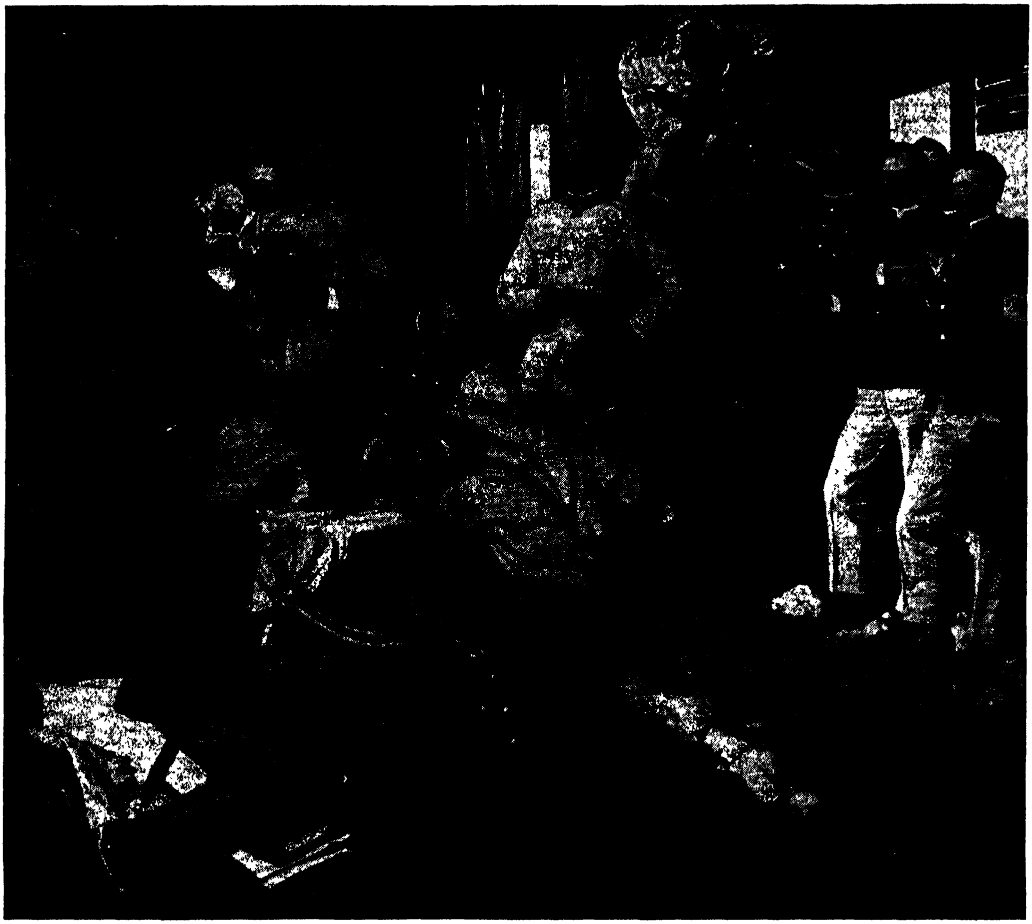
What this meant to the world we may see from one instance. The city of Ismailia, on the Suez Canal, in Egypt, was a plague-spot of malaria. Indeed, it was estimated that every single inhabitant of the town suffered from the fever. Major Ross was sent for, and in a few years' time he and his helpers had changed Ismailia into a health resort.

The mosquitoes breed in damp places, in little pools of stagnant water, and in swampy, marshy areas. In order to get rid of the disease-bearing insects, it is necessary to hunt them down and kill as many as possible, and then to clean and drain all the places where they might breed.

THE FIGHT TO CONTROL MALARIA STILL GOES ON

The fight to control malaria is still going on in many different parts of the world. In 1940 the Rockefeller Foundation sent men to the Burma Road to get rid of the malarial mosquitoes that were infecting the troops and truck drivers who were there, helping to get supplies to China. When the United States began building defense bases in Trinidad and other places in the British West Indies, malaria-bearing mosquitoes had to be stamped out in several of them.

Dr. Ross, who showed the way for all this achievement, received many honors. In 1902 he was awarded the Nobel Prize in medicine, and in 1911 the King of England made him a knight. Certainly no knight of King



Painting by Dean Cornwell, courtesy, John Wyeth & Brother, Inc.

This picture shows the beginning, on August 27, 1900, of the experiment that led to the conquest of yellow fever. Standing in the centre is Dr. Walter Reed, watching Dr. Lazear inoculate Dr. Carroll with an infected mosquito. General Leonard Wood, governor of Cuba, sits just below Reed. The elderly gentleman standing at the left is Dr. Carlos Finlay, a Cuban physician who had for years insisted that the fever was carried by mosquitoes. Standing at the extreme right is a group of volunteers for inoculation, including John R. Kissinger and John J. Moran of the Army Hospital Corps, the two men who refused to take any reward for their service to humanity. It was a daring experiment and these men volunteered in the full realization that they might not live to see the outcome.

Arthur's Round Table ever deserved this honor as much as did Sir Ronald Ross, conqueror of a modern dragon of disease.

While Ross was searching in India for the carrier of malaria, Dr. Walter Reed (1851-1902), a major in the United States Army Medical Corps, was searching in Cuba for the carrier of yellow fever. This, too, was found to be a tiny parasite that lives in the bodies of certain varieties of mosquito. How this was proved by Dr. Reed and his helpers is one of the truly heroic stories of the world.

Yellow fever is a tropical disease which had for centuries made life in the warm lands of the world a thing of suffering and uncertainty. Moreover, it did not always stay in the tropics. During the eighteenth and nineteenth centuries ships coming from the fever-infested ports of the Caribbean frequently brought the disease to northern cities, and there were terrible epidemics in Philadelphia, New York, Boston and other seaports. In one of these epidemics one-tenth of the people of Philadelphia died. From New Orleans the disease would be carried up the Mississippi River, far into the heart of the United States. Under Spanish rule Cuba was continually fever-ridden, and after the Spanish-American War Dr. Reed was sent to Havana to study this and other tropical diseases, and, if possible, to find a way of stamping them out and preventing new outbreaks.

In making his experiments Dr. Reed needed people who would be willing to be given the disease. First of all, two of his associates, Dr. Jesse W. Lazear and Dr. James Carroll, took this terrible risk. Carroll recovered, though it injured his health for the rest of his life. Lazear died of the fever, and the camp where this great work went on was named Camp Lazear in memory of him. Other volunteers were found, some of them United States soldiers, and others Spanish immigrants who had not been in Cuba long enough to catch the disease. Persons who had already had yellow fever did not make good subjects for experiments.

TWO SOLDIERS WHO SHOWED THE HIGHEST FORM OF COURAGE

To show how truly unselfish were the men who volunteered, we must tell you about two soldiers who offered themselves. They were to be bitten by suspected mosquitoes, and Dr. Reed talked the matter over with them, telling them about the danger and suffering that they would undergo. They were still determined, however, to go on with the experiment until Dr. Reed told them that they would be rewarded for their generous sacrifice. Then only did they hold back. Both of them declared that they did not want any money reward and that they would undergo the experiment only if the doctor would promise that there should be no payment for their services. Major Reed touched his hat to the soldiers and said: "Gentlemen, I salute you." He afterward said that in his opinion this exhibition of moral courage had never been surpassed in the United States Army.

THE FAR-REACHING RESULTS OF DR. REED'S WORK

The results of Dr. Reed's work are among the most remarkable that the history of medicine can show. One of the results was that yellow fever was practically wiped out in Cuba. In Panama the stamping-out of the disease made it possible to dig the Panama Canal. Earlier attempts to build a canal across the Isthmus of Panama had failed, largely because the people working there were attacked by the fever. After Walter Reed showed how to prevent the spread of the disease, the way was cleared for the carrying out of this great engineering project. First the United States Army sent Surgeon General Gorgas and his staff to Panama, and they set to work to destroy all the mosquitoes and to drain and clean their breeding-places. Then, when the Canal Zone had been made a healthful, sanitary region, the actual work on the canal was begun.

Although the researchers under Dr. Walter Reed discovered how yellow fever was carried and how to prevent it from being spread, they did not find the parasite that the mosquito carried. It seems that the organism which causes yellow fever is too small to be seen even under the microscope. Such a disease organism is known as a Virus.

Many other scientists tried to find, or isolate, the yellow fever virus. One of them was Hideyo Noguchi (1876-1928), a brilliant Japanese doctor who literally gave his life to medical research. He was a member of the Yellow Fever Commission which the International Health Board of the Rockefeller Institute sent to Guayaquil, Ecuador, in 1918. He did splendid work there in helping to stamp out the disease. There, too, by means of the so-called "ultra-microscope," he discovered a tiny spiral organism in the blood of several persons suffering from what seemed to be yellow fever. After

Hideyo Noguchi, the Japanese doctor who sacrificed his life to the cause of humanity in his search for the yellow fever virus.

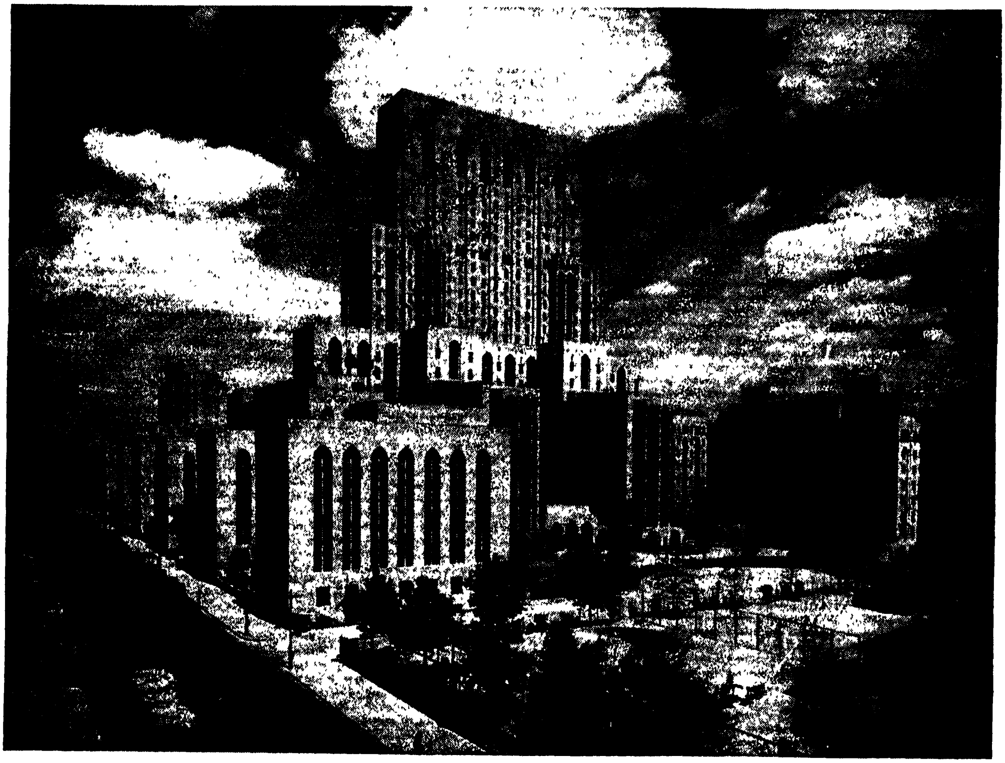
much research he became convinced that this organism was the yellow fever germ. All the evidence seemed to point that way. When blood containing the spiral germ was injected into healthy animals they promptly developed the symptoms of yellow fever.

Unhappily, as the years passed, fresh evidence was found which showed that Noguchi was mistaken. There are several diseases that resemble yellow fever closely. One of these is infectious jaundice, or Weil's disease, the symptoms of which are very hard to tell from those of yellow fever. This, it turned out, was really the disease that Noguchi's spiral germ caused.

Noguchi continued to work with the Rockefeller Institute in the effort to solve the problem of yellow fever. When he found that he had been mistaken in thinking that he had found the yellow fever virus, he started in all over again to search for the true virus. Finally, in 1928, he went to the west coast of Africa, which has always been a hot-bed of fevers and other tropical diseases, to continue his search. Here he became infected with the disease himself, and died without having gained the great desire of his life. Nevertheless, the enormous amount of work that he did was of vast importance, and remained as a foundation on which other scientists might build.

Another doctor who gained victories for medical science in the long war against tropical diseases was an Australian, Sir David Bruce (1855-1931). Bruce served in the British Royal Army Medical Corps and became surgeon-general. In 1903 he directed an expedition to Uganda, in Africa, and discovered that the dread sleeping-sickness was caused by the bite of the tsetse fly. Later he went to Malta, and investigated the disease called Malta fever, which was prevalent there and all around the shores of the Mediterranean. Bruce found that it was caused by a germ which infects the blood and the milk of goats. Since goats' milk is much used in that part of the world, the disease was easily spread.

Children everywhere should be grateful to the man who developed the treatment of



Photo, Ewing Galloway

This is the great East Side Medical Centre on the East River in New York City. It is one of the most impressive groups of buildings in all America, three blocks long and almost as broad. It contains several hospitals, besides the Cornell University Medical College, which occupies the central tower building.

diphtheria by means of diphtheria antitoxin, thus saving the lives of countless boys and girls. This was Dr. Emil von Behring (1854-1917), a professor in the University of Halle, Germany. Dr. Behring was awarded the Nobel Prize in medicine in 1901. He also developed a serum to prevent diphtheria, and he worked with Kitasato and Koch on tetanus.

We must now tell about an American doctor whose work means much to the health and happiness of thousands of people in the southern part of the United States. Dr. Joseph Goldberger (1874-1929) was born in Austria and came to America as a child. He was educated in the free schools and colleges of New York City, and received his medical degree from Bellevue Hospital Medical College. For a while he worked for the United States Public Health Service. In 1913 the Hygienic Laboratory in Washington sent him to the deep South—Alabama, Georgia and Mississippi—to study the dread disease, pellagra, which prevailed especially among the poorer white people.

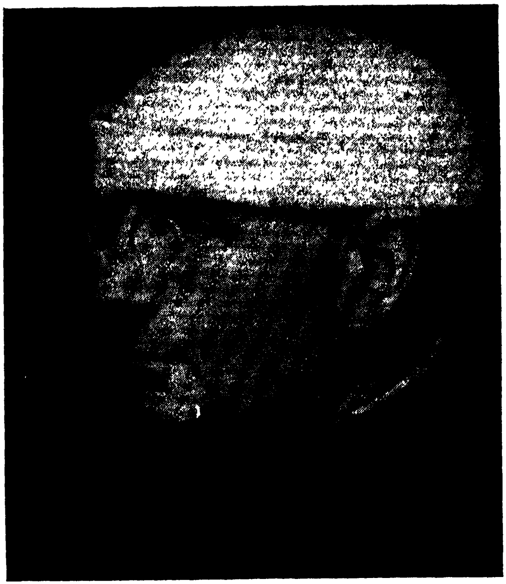
DR. GOLDBERGER PROVES THAT PELLAGRA CAN BE PREVENTED

Dr. Goldberger proved that pellagra is caused by the lack of certain elements, or vitamins, in the food that these people ate. He showed that it was possible, not only to cure the disease, but to prevent it by means of a properly balanced diet containing the pellagra-preventive vitamins. Dr. Goldberger was so devoted to the great work he had undertaken that he did not pay proper attention to his own health. He became ill and died at an age when many men are just reaching success in their work, but few men have done work as useful and noble as his.

One of the best-known leaders of medical science in our time was Dr. Alexis Carrel (1872-1944). Born in France and educated there, Dr. Carrel went to the United States a few years after he received his medical degree and became a member of the staff of the Rockefeller Institute. Much of his work was done there.

ALEXIS CARREL LEARNS HOW TO MEND BROKEN ARTERIES

One of Dr. Carrel's outstanding achievements had to do with the great blood vessels called arteries. Before his time the flow of blood from an artery that had been cut could be stopped, but ever afterward the artery would be useless. Dr. Carrel found a way to join the cut artery so that it could carry on its work as before.



Courtesy, Harper & Brothers

Dr. Alexis Carrel, the celebrated French scientist, lived in the United States for many years. During World War II he made a study of the effects of malnutrition on the people of war-torn Europe.

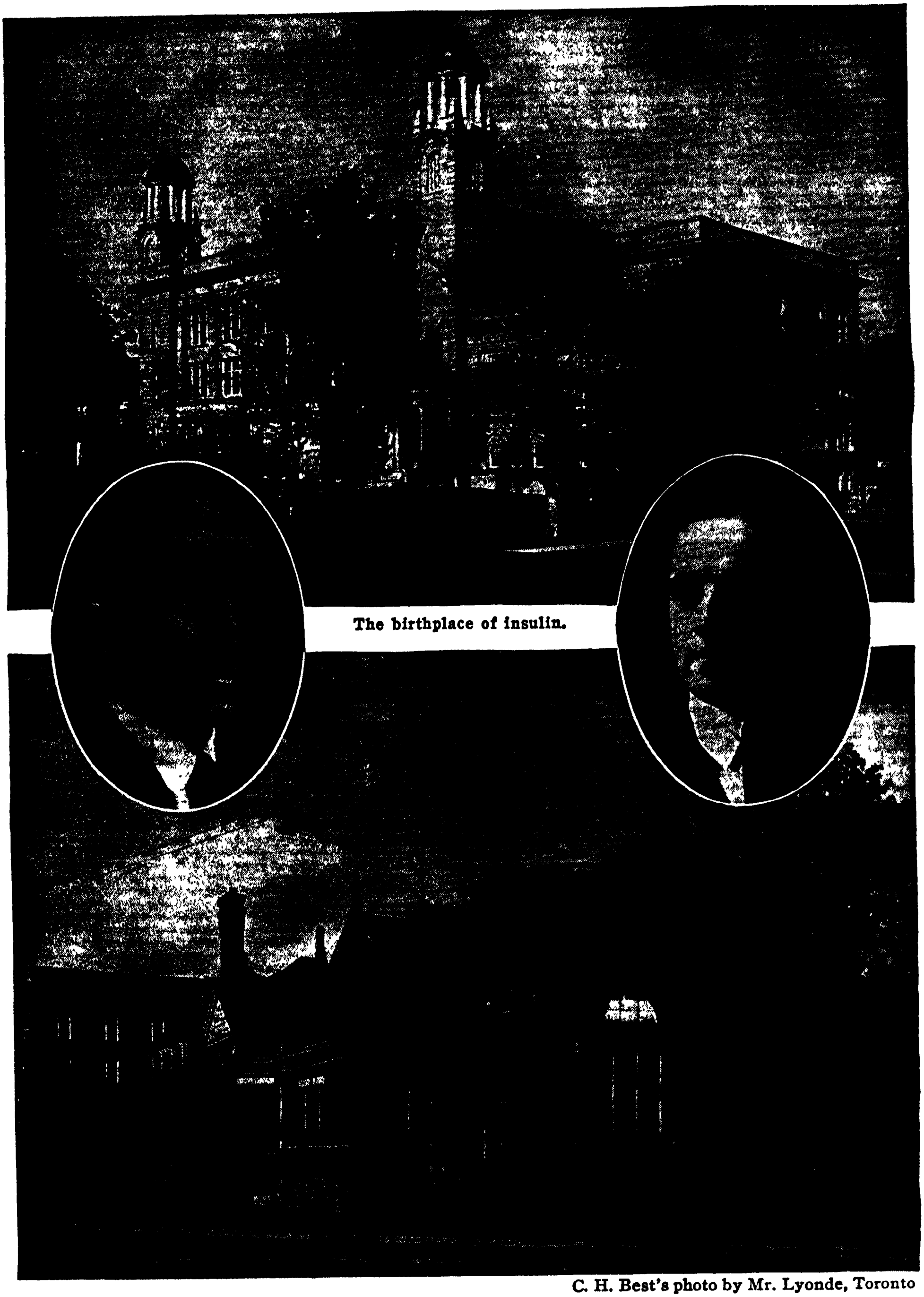
He made an intensive study of the tissue, or material, of which our bodies are built, and discovered that this tissue, if kept alive and healthy, will keep on growing. This discovery makes it possible to take a healthy bit of tissue from one part of the body and put it in the place of another piece of tissue that is diseased or that has been destroyed. This sort of patching had already been used in skin grafting, but Dr. Carrel's experiments with animals showed that it is possible to transplant bones and blood vessels and various organs of the body.

THE CARREL-DAKIN SOLUTION FOR STERILIZING WOUNDS

During the first World War, Dr. Carrel was in France, working among the wounded. While there, he and Dr. Henry Drysdale Dakin, a chemist and biologist, developed a new antiseptic for sterilizing gangrenous wounds. This was called the Carrel-Dakin solution. Dr. Carrel has received many honors for his achievements, and in 1912 he was awarded the Nobel Prize in medicine for his work in joining blood vessels. For a time Colonel Charles Lindbergh worked with Dr. Carrel in his researches. In 1935 they announced that they had invented a mechanical heart to be used in studying the organs of animals.

A discovery made by a young Canadian

VICTORS OVER DIABETES



The birthplace of insulin.

C. H. Best's photo by Mr. Lyonde, Toronto

Dr. Frederick Grant Banting (left) and C. H. Best (right), the two brilliant young Canadians who discovered insulin, which has saved the lives of many sufferers from diabetes. Insulin was first manufactured in the building shown above. Both buildings belong to the University of Toronto, Toronto, Canada. In 1941, Dr. Banting was killed in a plane crash in Newfoundland while on his way to England on a war mission.

doctor, Frederick G. Banting (1891-1941), was the means of bringing new hope and comfort to thousands of people suffering from diabetes. This disease comes when a substance called insulin, in one of the digestive organs, fails to carry out its part in digesting food. Insulin plays an important part in the digestion of the sugar that we eat. When there is not enough insulin to take care of the body's needs, the sugar in food can not be properly changed and the body suffers. Dr. Banting, with the assistance of Charles Best, a medical student who was his laboratory assistant, found out exactly what insulin was, how to obtain it from certain animals and how to use it in the treatment of diabetes.

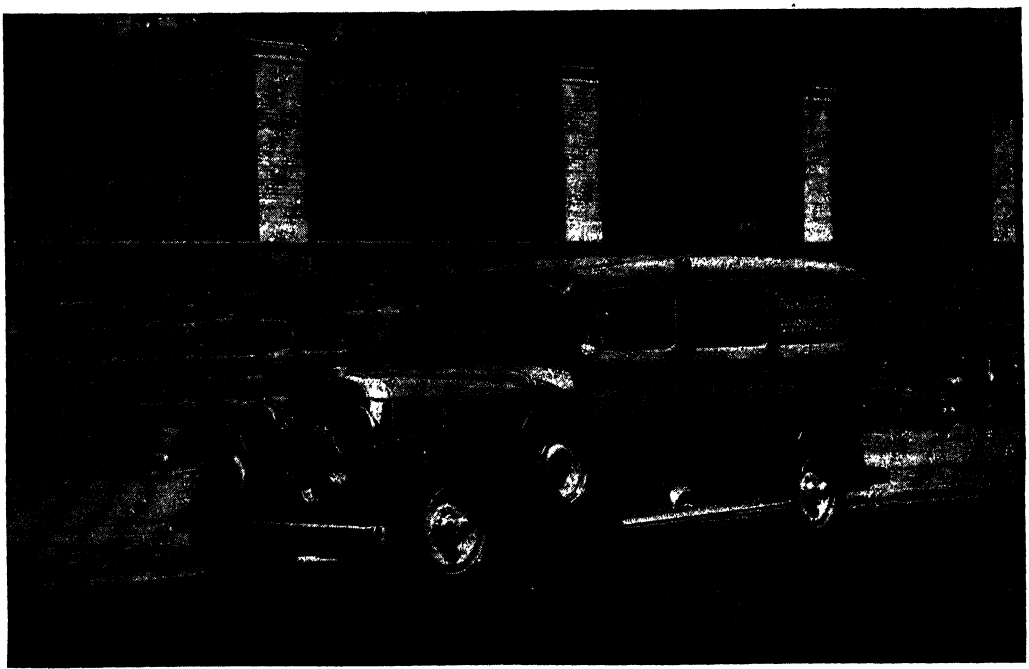
For this discovery, which was of the greatest benefit to humanity, Dr. Banting was made a knight. He, together with Professor J. J. R. Macleod, of the University of Toronto, who had made the research work possible, were awarded the Nobel Prize in medicine in 1923.

Sir Frederick Banting was a native of Alliston, Ontario, and was educated at the University of Toronto. During World War I he served for four years with the Army Medical Corps of the Canadian Expeditionary Force. He was wounded at Cambrai in 1918, and later received the Military Cross. When the war ended he practiced medicine and also taught in the University of Western Ontario for a short time, before he went to Toronto and started his researches.

When Canada entered World War II, Banting again gave his services to his country, and this time his life as well. While he was on his way to England on a war mission, his plane crashed in Newfoundland. Sir Frederick was fatally wounded, but before he died he managed to bandage the wounds of the injured pilot of the plane.

The men about whom we have told you in these articles are only a few of the many who have devoted their lives to the noble sciences of medicine, but they are among the greatest. Men of all nations, working together or separately, have brought increased health and happiness to the people of all nations. Wars may come and go, as they have done in the past, but these men of whom we have spoken deserve the gratitude of the people of all countries, for their gifts were freely given to all.

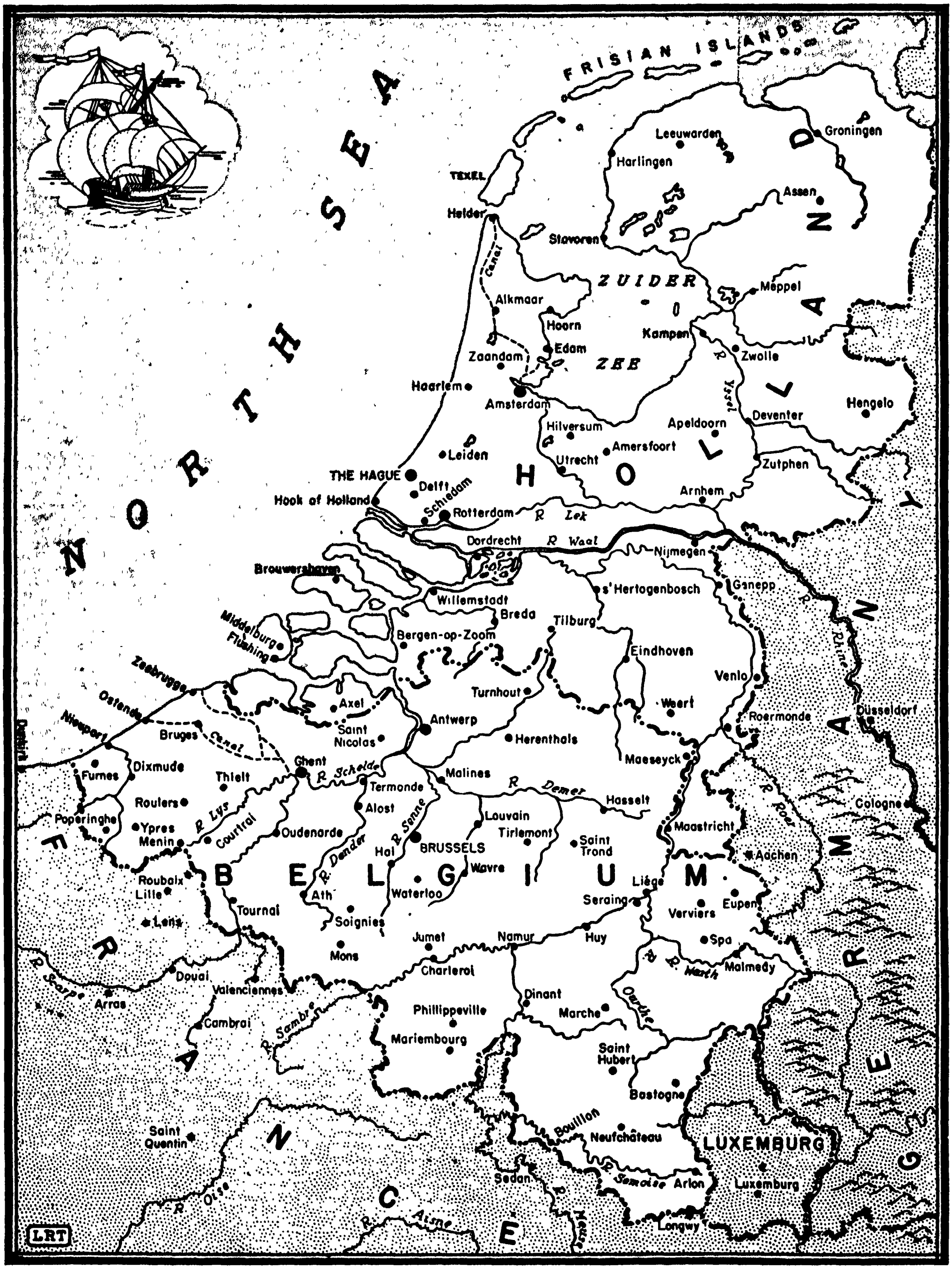
THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 5645.



Courtesy, Flower Hospital, New York

We are so used to seeing hospital ambulances that it is hard to believe that before 1869 no city in the world had this means of taking ill or injured persons to a hospital. Dr. Edward B. Dalton of the New York City Department of Health organized the first ambulance service, even helping to design this new kind of vehicle. In those days ambulances were horse-drawn, and it was many years before motor ambulances came into existence.

BELGIUM AND HOLLAND



Belgium is a small country, covering only 11,752 square miles; but it is densely populated, with more than 8,092,004 inhabitants. Most of the people live in the cities and towns, leaving only about 17 per cent to carry on the work of raising food. Much food is imported; and, in return, Belgium exports a wide variety of articles made by her industrious townspeople. Belgian lace has been prized for centuries. Linen, woollen and cotton goods, glassware, machinery and other iron and steel manufactures are among the most valuable exports.

BELGIUM
and
HER PEOPLE

Photo by James Sawders

A tree-shaded square in the business section of Ghent.

THE small country of Belgium—its area is 11,775 square miles—has always filled a very important place in European politics, trade and industry; and there are two reasons for this. First, it lies at the crossroads of western Europe, on the direct route between London and Berlin, and between Berlin and Paris. The second reason is that the people of the country have always displayed an untiring industry and perseverance.

Although Belgium is a small country, its surface is very varied, and its inhabitants belong to two distinct stocks. The old Roman road which ran from Cologne, through Maastricht, Tongres and Cambrai, to Boulogne, follows at a short distance the course of the Meuse and the Sambre rivers. Today the main line of railway follows very much the same course. By that route invading armies have marched into and across Belgium for centuries, and by that route the Germans advanced in 1914, at the beginning of World War I. This line is marked by a string of fortresses and by the battlefields of centuries, including the most famous of them, the field of Waterloo, which lies to the north near Brussels.

In the old Roman days the Silva Carbonaria, the great forest of the Ardennes, came right to the edge of the road, and a great part of the high land southeast of this line is still forest. In the wooded hills the Celts found refuge from Saxon and German invaders, and the Roman road which bounded the forest forms the language line of Belgium today, the line between the French-speaking Walloon population and the Flemish-speaking Teutonic people. If you draw on your map (page 5494) a line perfectly straight from St. Trond to Courtrai, you have the northern limit of French as the language of the common people. The two stocks are very much mixed, and French pushes its way north of this line. Educated people speak it everywhere in the country.

Belgium is the most thickly populated state in Europe. It has a population of between eight and nine million people, which means that on an average there are 710 persons to a square mile. This dense population is not gathered together in large towns as it is in England; even Brussels has not as many inhabitants as Birmingham, England. In the Flemish districts great numbers of people live outside the towns in houses with gardens or plots of land, the produce of which helps to eke out their wages. However, the Flemish worker is more apt to crowd into the towns than his Walloon brother. In the whole of Walloon Belgium there is only one place, Liége, which has more than 50,000 people, but the countryside is thickly dotted with industrial villages and with tiny homesteads. Rail and car services are good and cheap. Belgium has also an enormous colonial possession in Africa, called the Belgian Congo.

The hill country of the Ardenne region is a continuation of the highlands of western Germany and Luxemburg. It is really a plateau, in the hills of which deep gorges have been cut by the Meuse and the Sambre and their tributaries. This is the delightful and romantic country where the four sons of Aymon hid from the vengeance of Charlemagne. Near Dinant they still show the traveler the Roche Bayard, where the famous steed of Renaud, or Rinaldo, detached the great mass of rock from the mountain with a kick of its mighty hoof; and once a year, on the eve of St. John's Day, the peasants say that Bayard can be heard whinnying in the forest. The limestone which is to be found thereabouts has been worn by the action of rushing streams into a thousand strange shapes. Steep cliffs overhang the streams, and at Han is the famous labyrinth of grottos through one series of which runs the river Lesse. In the neighborhood of Dinant are great limestone cliffs and many curious limestone caves with stalactities hanging from the roof.

Photo by James Sawders
The deep-sea fishing fleet at Ostend.

To the north of the Meuse and the Sambre, in a line stretching for 115 miles from Liége to Namur, Charleroi, Mons and St. Ghislain, are the Belgian coal fields, with iron mines on each side of the rivers between Huy and Charleroi. The land of the Belgian black country lies about 150 to 600 feet above sea level, and slopes gradually to the northwest, being drained by a number of rivers which run into the Scheldt. The rich soil of the plains of central Belgium is excellently suited for agriculture. Every inch of it is cultivated. The Belgian farmer generally owns his small holding, and he and his family work very hard, in many cases producing two crops every year. The fertile belt stretches west into Flanders, and yields, under patient tillage, heavy crops of wheat, rye, sugar-beet, chicory, potatoes and all sorts of vegetables, grown for export to France and England in ordinary times as well as for the home market. In the sheltered valleys of the Meuse the vine is grown.

The whole of Flanders is densely cultivated. Its two principal rivers are the Lys, famous for the retting (the separating of wood from fiber by soaking) of flax, and the Scheldt, on which the great medieval free cities of Ghent and Antwerp grew up. To the northwest of the Lys lie low hills running in a line from Hazebrouck to Ypres. But the most fertile district of Flanders is the strip of low-lying country, from five to ten miles broad, running along the coast from Dunkirk on the other side of the French frontier to Antwerp.

This land is protected from the sea by a system of dunes a mile or more deep, and is drained by canals filled with fresh water. Between the canals lie the rich pastures known as polders. Near the French frontier the polders have to be kept dry by pumping. These districts were flooded by the Germans in 1944 as a means of defense.

Ewing Galloway
The cattle market at Bruges where farmers trade or sell cattle.

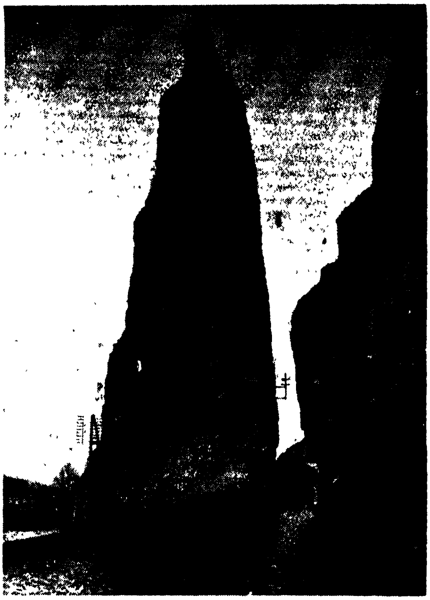
There are no natural harbors, but the mouths of the Yser at Nieuport, and of the canals at Ostend and Zeebrugge, have been made available for ships. All along the dunes, before World War II, there were watering-places with casinos and promenades—almost continuous thin lines of villas and hotels—for people who enjoyed the sea-bathing. Ostend was one of the gayest watering-places in Europe.

On the inner edge of this strip lies Bruges,

QUIET SPOTS IN A BUSTLING COUNTRY

Photo from European

The River Meuse, seen from the Citadel Park, Namur.



Publishers Photo Service

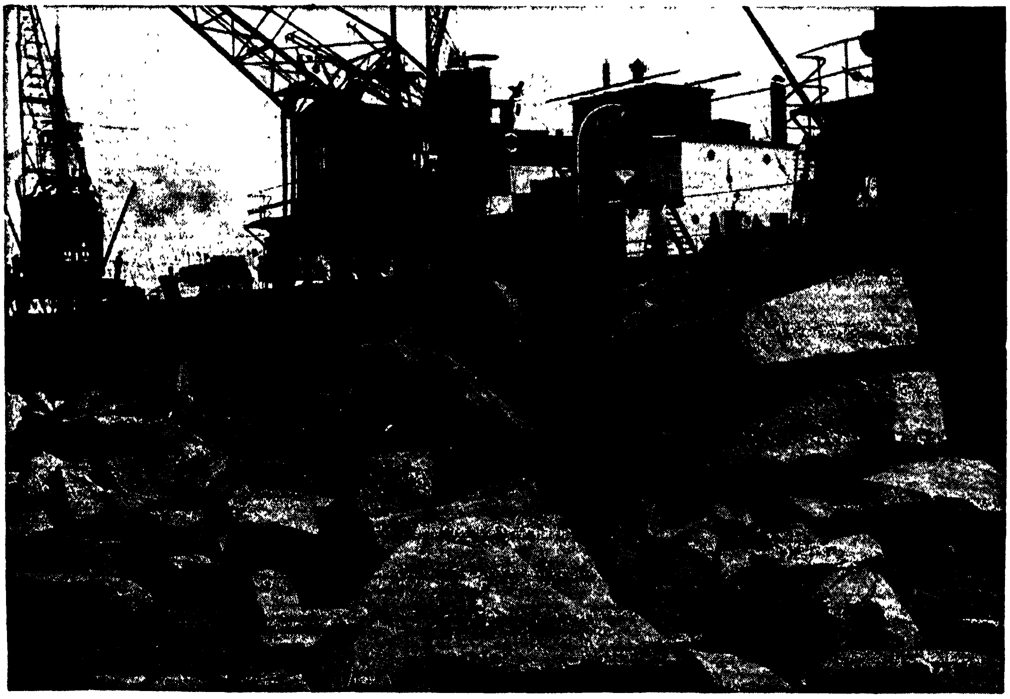
Bayard's Rock on the Meuse, at Dinant.

Burton Holmes, from Ewing Galloway

A quiet scene along a sleepy canal in an old section of Ghent, third largest city of Belgium.

CANAL PORT AND SEAPORT

A canal dock, Brussels. Belgium is crisscrossed by a thousand miles of inland waterways, canals and rivers.



Both pictures Evans from Three Lions

A cargo of onyx from South America is unloaded from a vessel at Antwerp, one of the world's great seaports.

at the junction of canals leading to the sea. This low-lying country is the first glimpse the traveler sailing up to Antwerp has of Belgium. Grass of a dazzling green, bordered here and there by a slip of shining sand between it and the water's edge, and tiny houses of red brick; and presently, the great cathedral tower and tall warehouse of Antwerp— just the same bright-colored land-and-water landscape as is characteristic of the Dutch coast. Large districts of Flanders have a very sandy soil. The long straight roads are lined with trees, and the ditches are lined with hedges which help to bind the sandy soil.

Photo by James Sawders

Some of the five thousand hothouses of Hoeylaert, where early grapes are grown.

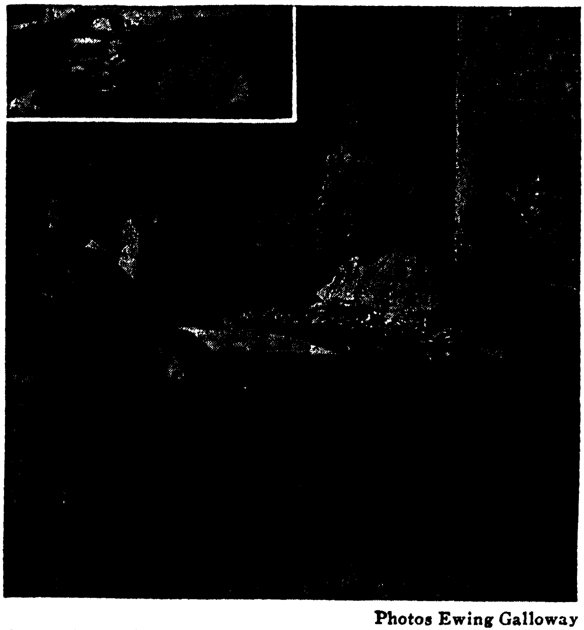
Away to the northeast, north of a line drawn from Malines to Maastricht, is a continuation of the coastal plain, a huge tract of barren sandy country, which even Belgian industry has failed to make fertile. This is the Campine, or Kempenland, which stretches across the Dutch and German borders. Until not so long ago this was regarded as waste land fit for nothing but fir and larch. But it holds that most precious of gifts to an industrialized country, the "black diamonds" of coal. The coal is close to the surface, and makes good coking coal for the iron industry.

The development of the coal industry changed the face of this desolate, barren country, and busy industrial centers grew up like mushrooms. The sand, too, is excellent for glass, and all sorts of raw materials pour in through the port of Antwerp, which is close to the coal region. New railway lines were built, and the Albert Canal, connecting Liége and Antwerp, was opened in 1939. In 1918, Belgium produced 13,500,000 tons of coal; her production in 1939 was more than twice that amount, and more than 125,000 people were employed in the industry.

Belgian enterprise led to prosperity in the twenty years following World War I. One item is the thrifty way in which electric power has been generated in gigantic stations, from where the current is transmitted to distant points. Good, cheap electrial power lessens the cost of production enormously, and the industrial area in the Campine profited by the well-planned power arrangements.

The most important heavy industries have been steel, mechanical construction (bridges, girders, building frames, pumps, cranes, motors, engines, boilers and rails). These are grouped on the coal-fields, the chief centers being Liége and Charleroi, though there are also important works at Brussels, Ghent and Antwerp.

The making of sheet and plate glass, in which Belgium excels, is also mainly carried on near the coal-fields. Zinc, with its by-



Photos Ewing Galloway

Lacemakers of Bruges: above, a close-up of this fine work.

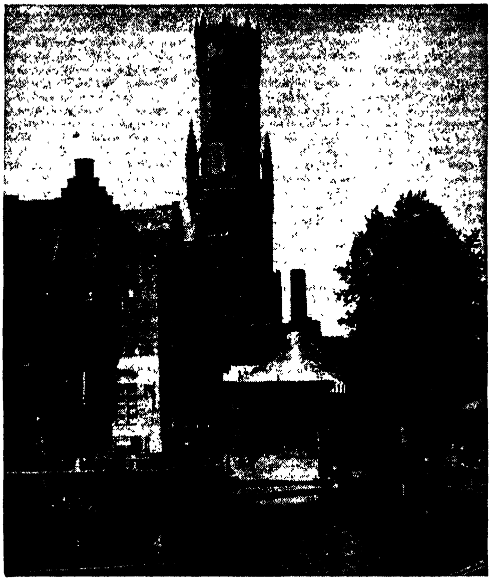


Photo by James Sawders
The bell tower of Bruges, famous in song and story. It contains a fine carillon of forty-eight bells.

product sulfuric acid, one of the most valuable of Belgium's natural resources, is found between Liége and Aix-la-Chapelle, and is treated on the Sambre-Meuse coalfield and in the Campine. Pottery, paper and works for the production of industrial chemicals are scattered all over the country; cotton and linen mills are found at Ghent and elsewhere in east Flanders; woolen-cloth factories in and around Verviers, Antwerp and other places; tapestries and fabrics of mixed cotton, silk and wool are made around Courtrai; carpets at Brussels and elsewhere; and lastly there is the diamond industry of Antwerp. Generally speaking, wages have been low and the workmen poor, but conditions have lately been improving. One of the things they tried to do in Belgium was to give workingmen an addition to wages according to the number of children in the family.

There is a sizable sugar-beet industry, with a number of factories making raw sugar, and others refining it. The fisheries are also important.

The Belgians made great strides in foreign trade after 1918. The excellent port of Antwerp was developed and improved until it became a rival to Rotterdam and Hamburg. It is in a strange position, however, for the south side of the broad estuary on which it stands is Dutch, as well as the islands. A small piece of what looks as if it must be Belgian mainland has remained Dutch.

For this reason, the Belgians worked hard, developing the artificial port of Zeebrugge into a first-class harbor. A train ferry ran between Harwich, England, and Zeebrugge, so that fragile goods could be shipped without the cost and hazards of lading and unlading at the ports.

Ghent, with a deep ship canal northward to Terneuzen, in Holland, and other canals westward to Bruges, Zeebrugge and Ostend, was a busy port. So was Ostend, and this city also extended her harbor.

In spite of all this development and in spite of the storms of war and revolution which have swept over her repeatedly in the last two hundred years, Belgium is, perhaps, the best country in Europe in which to study the medieval civic life and organization of northern Europe. The monuments and the arts of the prosperous centuries before Spain broke the Low Countries are still preserved.

Bruges is a fine example of the industrial city of those days. Before there was thought of pulling them down to make room for modern factory and workshop, the houses and buildings of mellow red brick in her ancient streets and along the quiet canals made men call her the Venice of the North. (However, Stockholm, Sweden, also lays claim to this name.)

In the thirteenth and fourteenth centuries, when the communes were freeing themselves from the feudal lords and building up the

Photo by James Sawders
The Ostend Gate, once part of the walls of Bruges, which served as fortifications in medieval times.

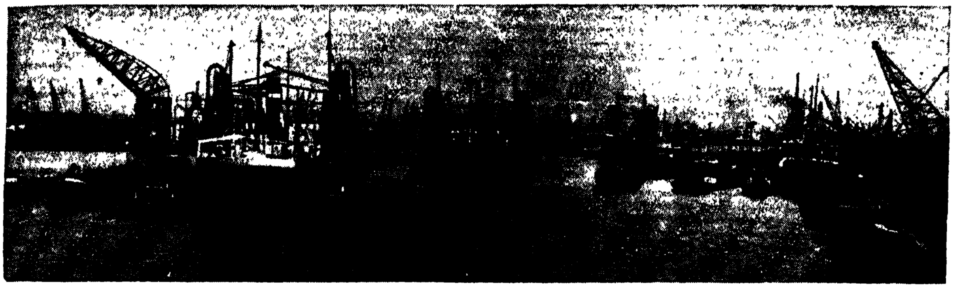


Photo by James Sawders

Antwerp is one of the great ports of Europe. Here we see barges with grain-suction machines unloading ships. The city is on the right bank of the Scheldt River, about fifty miles from the open sea.

industry and trade which were to make the Flemish cities a marvel to later travelers, the townspeople built the market hall with its belfry, often containing the marvelous carillon in which Belgian metal-workers excelled. This hall was nearly always strongly built and capable of defense. The tall belfry which ornaments so many Flemish cities, sometimes built as part of the *Halles,* or markets, sometimes, as at Ghent and Tournai, a separate building, was a sign of the independence of the citizens; from the belfry the bell called the burghers to work and prayer, and the tocsin called them to arms to defend their liberties in case of need. (A signal of alarm sounded on a drum or especially on a bell is called a tocsin.) Here and there as at Ghent, the rival building, the fortified castle, still exists. There are many magnificent examples of this civic architecture in Belgium—the Cloth Hall of Ypres, with its beautiful long lines and high-pitched roof, now, alas, destroyed by shot and shell; the *Halles* and belfries of Bruges, of Ghent and of many another less famous town. The oldest of these belfries is at Tournai, for the building of which a charter was obtained from Philip Augustus of France in 1187. These are typical of old Belgium.

Later, in the fifteenth and sixteenth centuries, when these same towns built their towns halls, the architecture became highly ornate and decorative. The idea was to display the splendor and riches of the town and its artistic genius. Perhaps the most magnificent of the many fine town halls in Belgium

Belgian official photo

The people of Brussels enjoy their sidewalk cafes.

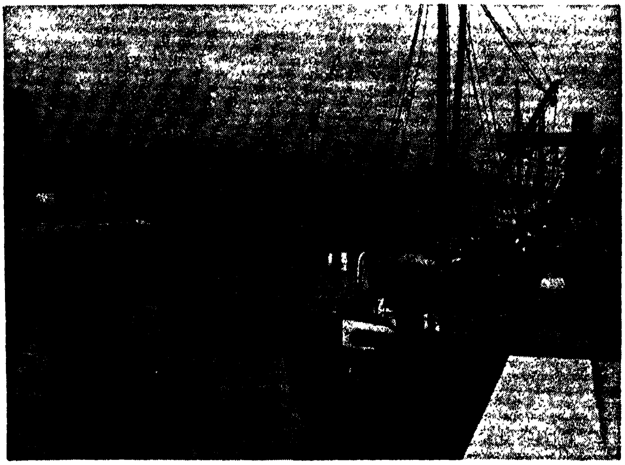


Photo by James Sawders

Along the busy Willsbreeck Canal in Brussels, near the Custom House.

ARCHITECTURAL GEMS FROM THE PAST

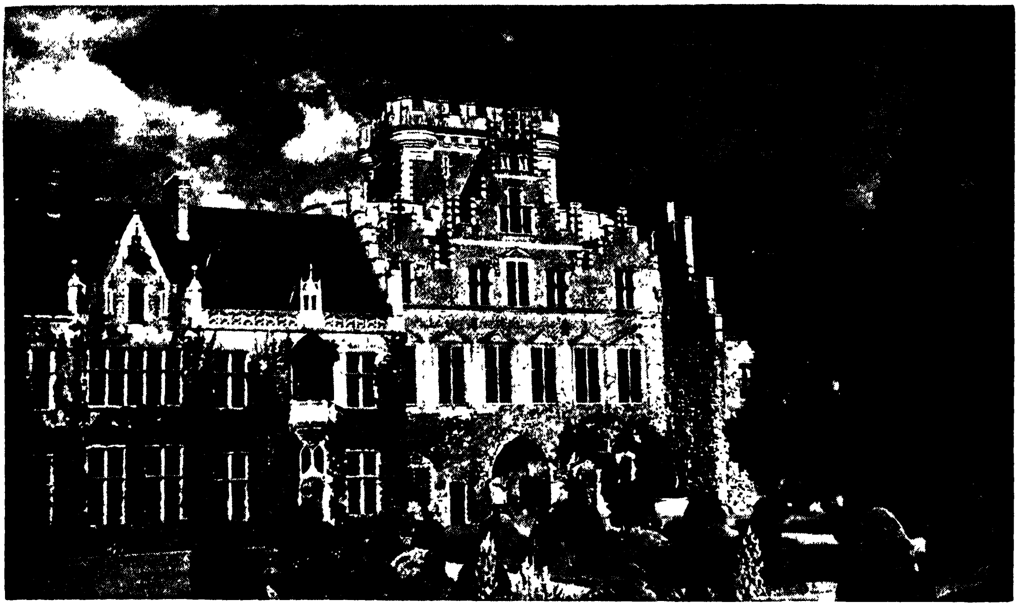


Photo from European

Courtyard of Gaesbeek Castle, a chateau built in Renaissance style, with "English" garden of clipped privet.

James Sawders

The Guildhall at Ghent (second from left). Many mediaeval buildings in the Low Countries had high peaked fronts.

Photo from European

The church and statue of Ambiorix at Tongres

is the Hôtel de Ville on the Grande Place in Brussels

The Grande Place is a wonderful square. Opposite the highly decorative Hôtel de Ville is the splendid Gothic Maison du Roi, or Bread House, and on the other sides stand the old houses of the merchant guilds, with their high pointed gables, their balconies and their quaint sculptures The town hall of Louvain, which luckily escaped when the library was twice destroyed by wars, is a highly decorated example of Belgian civic art, but it has been much restored.

Nowhere in Europe has civic architecture been more magnificent than in the Flemish cities. A nation of merchants and craftsmen, subject for centuries to foreign rule, they found freedom and self-government in the city, and nothing was too good to express its greatness.

The old Belgians were also a deeply religious people. They looked up to the saints as the founders of their loved cities. Had not St. Amand founded Ghent when he pitched his monastery at the junction of the Scheldt and the Lys? Their art and their industry they owed in many cases to the monks. Most of the churches built in the days of Charlemagne and the following centuries in the Romanesque manner have perished, but parts of the Church of St. Guy, at Anderlecht, of the minster Church of Nivelles, of some of the churches at Bruges and of that of St. Servatius at Maastricht, go back to this period.

But most of the great churches are built in the Belgian Gothic style; this was introduced in the cathedral at Tournai in the twelfth century by French architects, but the builders of great Belgian churches adapted it and made it national. The octagonal towers, the rounded turrets, and the width and spaciousness of the interiors give them their peculiar beauty.

The architects of Brabant were famous all over Europe. The Cathedral of St. Rambaut at Mechlin, with its mighty square tower; of St Bavon at Ghent, the Church of Notre Dame du Sablon at Brussels, built for the Guild of Crossbowmen; the great Church

Photo by James Sawders

The beautiful Town Hall of Bruges, with the Palace of Justice at the left. The hall is decorated with numerous statues and airy towers.

of St. Gudule at Brussels, with its two towers; and Antwerp Cathedral, of whose western towers only one was finished, to serve as a beacon to mariners on the Scheldt —these are only some of the wonderful Belgian Gothic churches.

Originally these churches were brilliant with color, with mural paintings and with gold. Every kind of craftsmanship was lavished on them, in sculpture, in stone and wood, in brass, copper and ironwork, in tapestry, in stained glass, and in painting. Much of this treasure was destroyed by the Calvinists in the sixteenth century, and the churches again suffered in the French Revolution in 1793, but much remains. The painters of each town in the fourteenth century formed themselves into a guild, like other tradesmen, but they did not confine themselves to easel work; many of them practiced other crafts as well. Like the Greeks, the Belgians preferred their statues colored. Jan van Eyck himself colored some.

The Flemish cities, too, are rich in paintings of the great Flemish religious school. We may see great pictures by Roger van der Weyden, the brothers Van Eyck, Quentin Massys and the rest in galleries, but it is better to see them in the churches for which they were originally designed. In the old Hospital of St. John at Bruges, are the best works of Hans Memling. Hubert and Jan van Eyck's Adoration of the Lamb is associated with the Cathedral of St. Bavon, at Ghent. To Jan van Eyck is generally ascribed the discovery of the art of painting in oil; the colors of his great pictures are still fresh. Antwerp Cathedral counts among its treasures Rubens' Elevation of the Cross and Descent from the Cross, and on the high altar is the same painter's Assumption. Rubens painted many pictures for the Jesuit churches, some of them gay and full of the pleasure of life and far from devout, but the Jesuits did not hesitate to press secular art into the service of religion. Some of these paintings were scattered during World War II, but may eventually return to their original resting places.

A charming type of Belgian architecture is that of the tranquil squares and gardens surrounded by low houses and adorned by a church. In the fourteenth century were devout men and women who took no religious vows, but found refuge from the world in these quiet places, working for their living with their hands and giving their leisure to prayer. Some of these communities remain; they were for aristocrats, but most of them are now for simple working people.

These places have provided many poor men and women with a quiet home. Many were destroyed at the time of the French Revolution, and many have now been secularized. At Louvain is one of the most charming of these Old World places; there is one at Bruges, on the bank of the Roya, and in Ghent there are two, so large as to be almost little villages by themselves.

The Belgian people are mostly Catholics, but their constitution insures complete religious freedom and equality to all faiths. Their system of public education includes state support for religious and other private schools. There are numerous colleges and

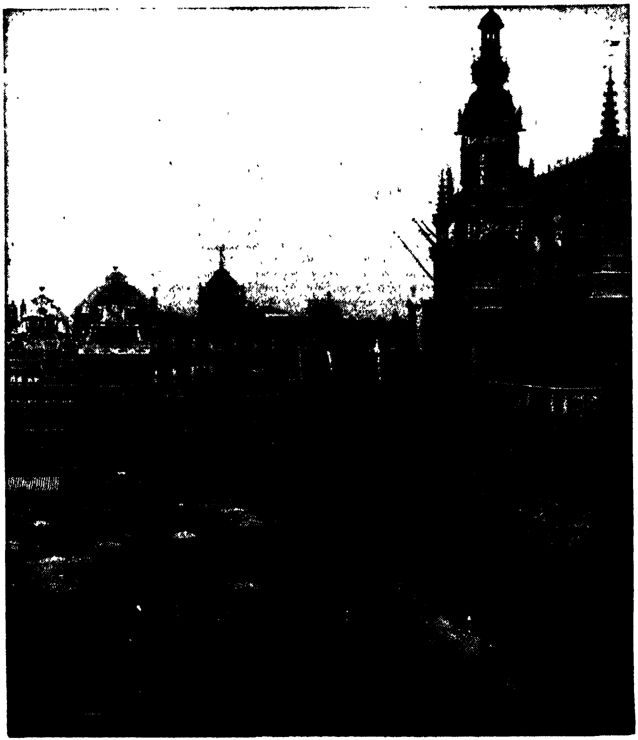
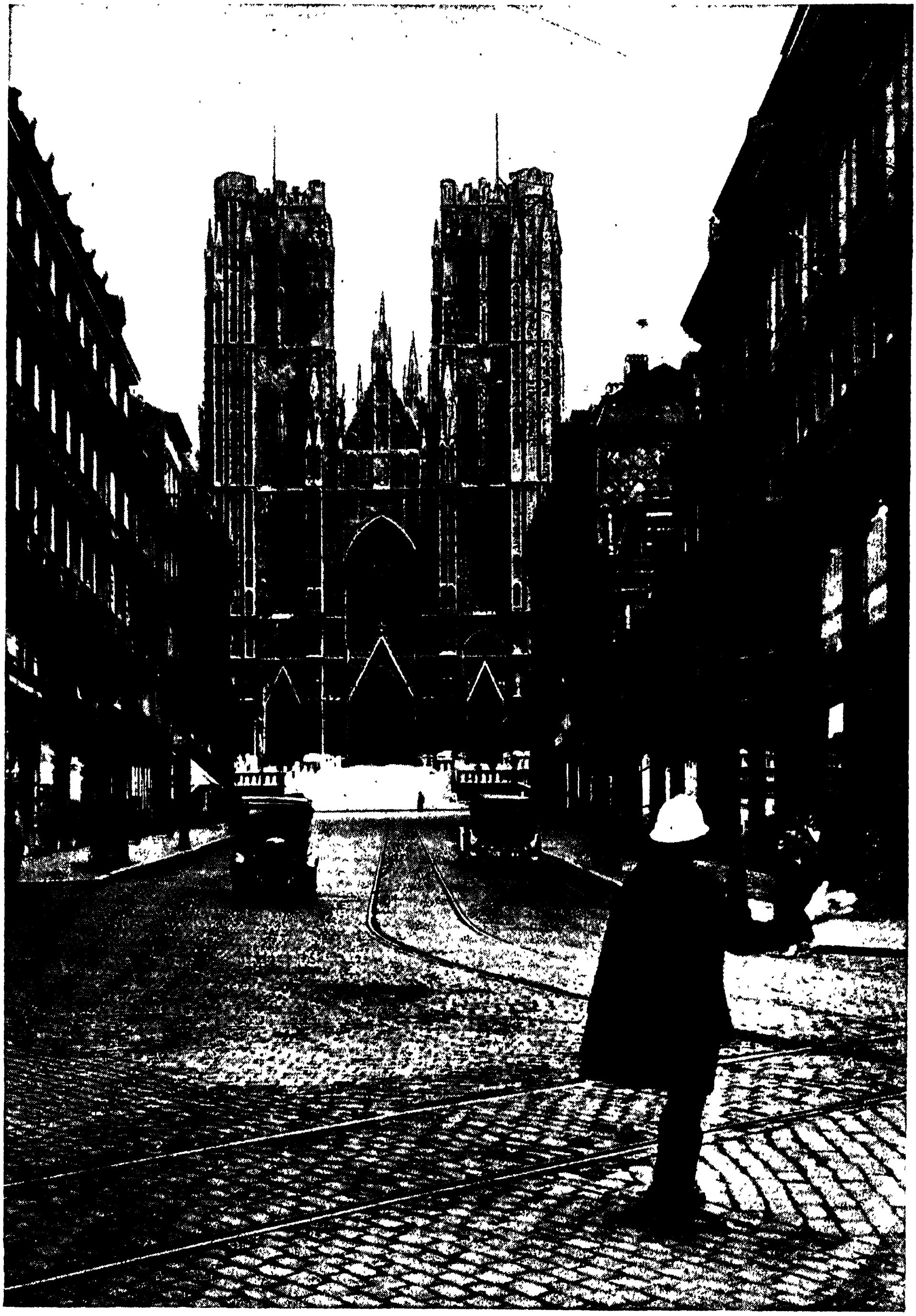


Photo by James Sawders

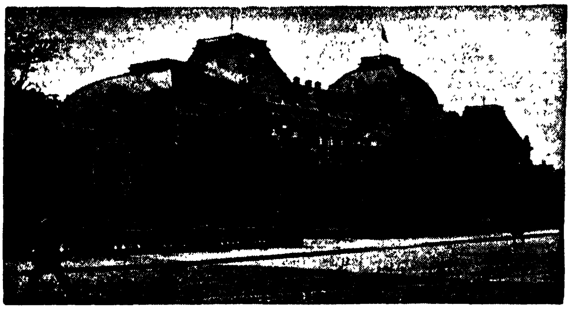
The Grand Place, a famous square in Brussels, Belgium's capital.

THE BEAUTIFUL CATHEDRAL AT BRUSSELS



Evans from Three Lions

The fine Gothic cathedral of St. Gudule, begun in 1226, is on the site of an earlier church.



Belgian official photo

The Royal Palace at Brussels, official home of the King.

special institutions of learning. The universities of Brussels, Louvain, Ghent and Liége are well known, those at Ghent and Liége being state institutions.

The history of modern Belgium as a separate kingdom begins only in 1830. Before that time it was united with the Dutch provinces in what was known as the Netherlands, or was subject to other countries. More can be read about this in the article on the Netherlands, the official name of present-day Holland, later in this volume. We may note that the able diplomat and soldier, Alexander Farnese, brought about the separation of the Belgians from the Dutch. When the northen provinces of the Netherlands broke away from Spain in 1579, and formed an independent kingdom, Farnese persuaded the southern provinces to remain under Spanish rule. At different times Spain, Austria and France ruled this territory; and after Napoleon's fall it was again united to the Dutch provinces in the Kingdom of the Netherlands, under a Dutch king.

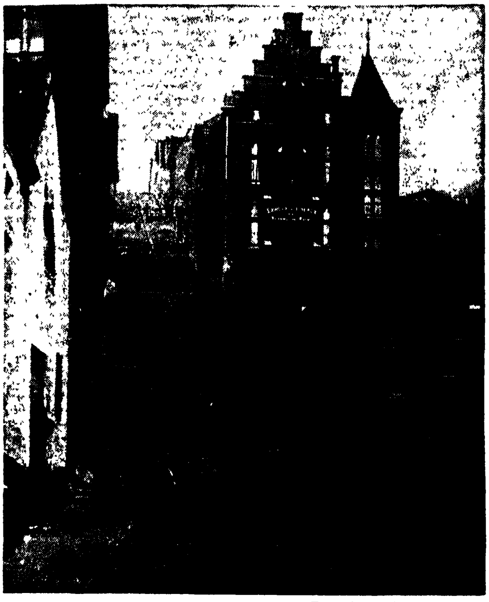
When Belgium obtained her independence in 1830, she chose as king Leopold of Saxe-Coburg, an uncle of England's Queen Victoria. A democratic constitution was drawn up, with an elected Senate and Chamber of Deputies as the legislature, and the king as executive, with limited powers.

The country prospered, and was supported by England in the disputes with Holland over territory. These concerned Antwerp and parts of Limburg and Luxemburg. Under her second king, Leopold II, Belgium acquired the great overseas territory of the Belgian Congo in Africa. This was a further source of prosperity, but was sometimes ruled with cruelty and injustice.

In 1909 Albert I (1875-1934) became king, and five years later he became a world figure in opposing the German invasion. With Cardinal Mercier of Malines, King Albert symbolized the national spirit during the long enemy occupation of the country. Relief work from abroad was necessary to feed the starving people, and this was headed by an American, Herbert Hoover. Normal conditions were soon restored.

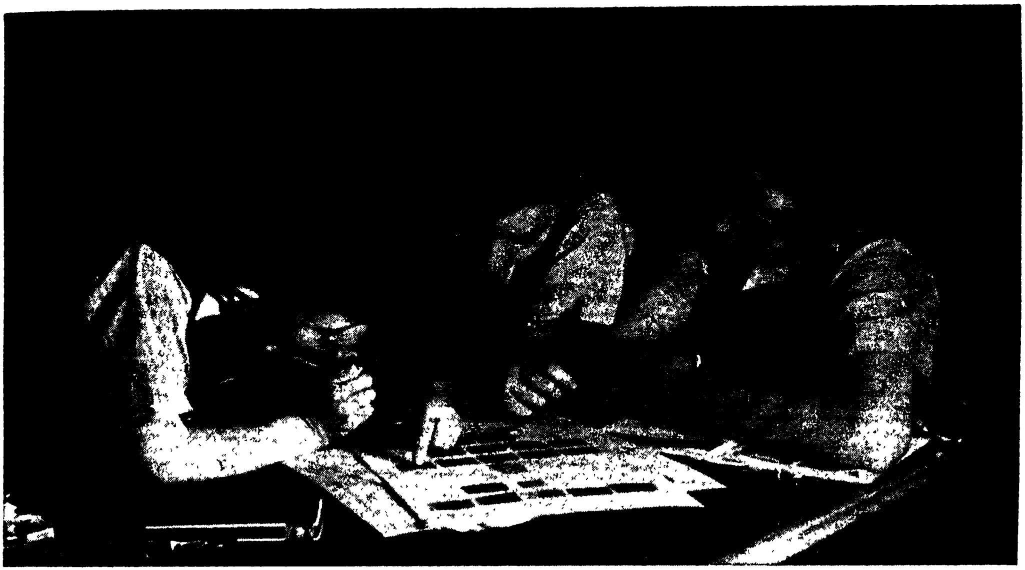
Belgium again became prosperous: soon, however, the shadow of Hitler arose to threaten all Europe. Belgium's fourth king, Leopold III (1901-) hoped to keep his country from another war. He broke off the defensive alliance with France, as a proclamation to the world that Belgium wanted to remain neutral. A result of this was that the famous French Maginot Line could not be extended to the coast. This was perhaps an important fact in the fall of France in 1940. In that year the nazi armies swept into Belgium, and her military forces surrendered by order of the King. Again the country was subjected to German occupation. Liberation came only in 1944. During the years of occupation, Leopold was a prisoner of the Nazis. A government-in-exile carried on in London. The exiled government returned to Brussels in September, 1944. The King, however, did not return; and his brother, Prince Charles, continued to act as regent.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 5554.



Belgian official photo

An old Liége street turns into a flight of stairs.



Stern, from Monkemeyer

STAMP COLLECTING

THE collecting of postage stamps is a hobby that interests persons of all ages and in all the walks of life. It has numberless followers in every land. There are over two million stamp collectors in the United States and Canada, and among these are a great many boys and girls.

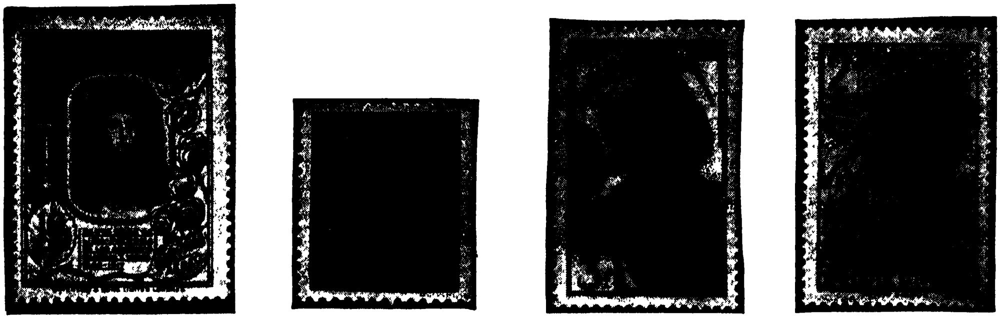
The most valuable stamp in the world is the one-cent British Guiana magenta of 1856. Only one copy is known to exist; this is valued at about $50,000. There are other stamps worth several thousand dollars; many others valued at hundreds of dollars. Yet most stamps are not expensive. There are hundreds of stamps worth a few dollars and many more hundreds that you may buy for a few cents. So you see that stamp collecting is not merely a rich man's hobby.

Each stamp collector finds his own stamps fascinating, no matter how much or how little money he spends on them. The reason is that there is always a story behind postage stamps. The countries of the world use them as a means of telling the world about their industries, their culture, their great men. They also use stamps to celebrate important events in their history. So while a stamp collector is enjoying his hobby, he is also storing up knowledge about all kinds of things in every corner of the globe.

Usually a beginner collects everything that comes his way. This is the best method, as in this way he will become acquainted with a wide variety of stamps. Later on he may decide to specialize in certain kinds. But unless he has already collected all sorts of postage stamps, he will not have enough general information about his hobby to enjoy it to the full.

It is a simple matter to acquire postage stamps. Grown-up relatives and friends will be glad to give you stamps from the letters they get at home or at their place of business. You may buy packets of stamps at a low price in five-and-ten-cent stores, department stores or stationery stores in almost every town. In the larger cities there are stamp shops. When buying stamps, ask for a "variety" packet. A 500-stamp variety is a most desirable size for the junior stamp collector.

In collecting stamps you will find yourself acquiring many duplicates. You will be able to add to your collection by exchanging these duplicates for stamps of equal value. An accurate guide to the value of stamps is Scott's STANDARD POSTAGE STAMP CATALOGUE. Young collectors who do not find it possible to buy this important catalogue may use it at the public library.



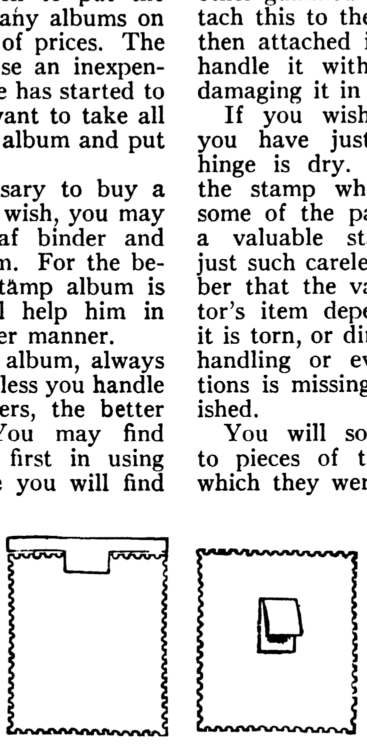
Girls will find it interesting to make a collection of fashions in headdress. The stamps shown above, reading from left to right, are issued by Peru, Switzerland, French Guiana, and the Ivory Coast, a French possession.

Once you have begun your collection, you will need an album in which to put the stamps. There are a good many albums on the market, at a wide range of prices. The beginner should always choose an inexpensive album. Later on, after he has started to specialize, he will probably want to take all of his stamps out of his first album and put them in another one.

It is not absolutely necessary to buy a regular stamp album. If you wish, you may buy an inexpensive loose-leaf binder and ruled sheets in loose-leaf form. For the beginner, however, a regular stamp album is more satisfactory, as it will help him in mounting stamps in the proper manner.

In putting stamps in your album, always handle them with tongs. The less you handle your stamps with your fingers, the better their condition will be. You may find yourself a little clumsy at first in using the tongs. But after a time you will find it easier to handle your stamps with tongs than to use your fingers.

Stamps should always be mounted in the album with peelable hinges. These are small transparent bits of paper with a special type of peelable gum on the back. They may be removed later without tearing any paper from the back of the stamp. Peelable hinges are so inexpensive that anyone can afford to buy them in quantity.



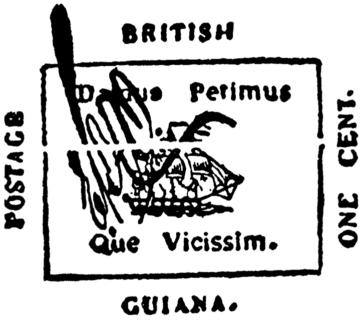
Two different ways of fixing postage stamps to the pages of the album.

In mounting the stamp, fold over about one-quarter to one-third of the hinge, with the gum on the outward side. Wet your finger tip slightly, and with it moisten the folded-over portion of the hinge. Attach this near the top of the back of the stamp that is to be mounted. Then moisten the other gummed portion of the hinge and attach this to the album page. The stamp is then attached in such a way that you can handle it without creasing the stamp or damaging it in any other way.

If you wish to remove a stamp that you have just mounted, wait until the hinge is dry. If you pull a hinge from the stamp while is is wet, it will take some of the paper surface with it. Many a valuable stamp has been ruined by just such careless handling. Always remember that the value of a stamp as a collector's item depends upon its condition. If it is torn, or dirty, or made thin by careless handling or even if one of the perforations is missing, its value is greatly diminished.

You will sometimes find stamps stuck to pieces of the envelope or wrapper in which they were carried through the mails. These stamps are generally removed from the attached paper by means of water. Before you use water on them, be sure that they are not printed with an ink that runs easily. You will soon be able to tell what stamps are printed with this "fugitive ink," as it is called. Such stamps should not be treated with water, but should be left with the paper attached.

Most stamps, however, may be removed from the attached paper by water without spoiling either the color or the design. Simply place the stamp face upward in a saucer of lukewarm water. In a few minutes it will be free of the paper. Do not try to force



The world's rarest stamp.

it loose. If you do so, you are likely to tear off some of the paper from the back of the stamp itself. Such "thinned" stamps are worth less than those in good condition.

After removing the stamp from the water, place it on a piece of dry cloth; pat off the excess water. Then put the stamp between two pieces of blotting paper until it is thoroughly dry. If you place a book over the top blotter while the stamp is drying, the stamp will not curl.

Stamped envelopes (those which have the stamp printed upon them), postcards and newspaper wrappings should be preserved complete or else in "cut square." A cut square is prepared by cutting from the envelope a square section containing the stamp.

Old envelopes with stamps that are no longer in use today are more valuable at the present time than ever before. They are particularly valuable when they are in fine condition and are "tied on." When we say that a stamp is tied on, we mean that the postmark is stamped on the envelope in such a way that part of the mark is on the stamp and the rest of it is on the envelope, or "cover," as it is called.

After you have been collecting stamps for some time, you will probably want to specialize in certain kinds of stamps. Some people collect the stamps of certain countries only. Others collect stamps showing certain subjects: animals, birds, children, buildings or paintings. Many professional men—doctors, musicians, artists, lawyers—make collections based on their life-work, and fine collections they are.

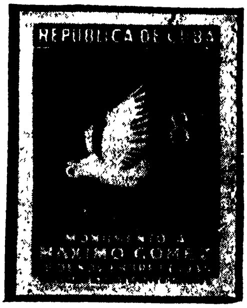
Perhaps you will want to start a collection that tells a story—the story, say, of aviation. You will find on stamps pictures of all sorts of flying craft, old and new—monoplanes, biplanes, flying boats, dirigibles, balloons, parachutes, even kites. Again, stamps have been issued for special flights, such as transcontinental, transatlantic, transpacific, North Pole, South Pole and stratosphere flights. A number of stamps show noted pioneers of aviation.

The history of the past may be studied in the stamps issued in days long gone by. Sometimes, too, recent stamp issues commemorate events and persons of former times. For example, during 1940 the United States issued a notable set of stamps to honor great Americans of the past. The men and women who were thus honored had won fame as authors, poets, scientist, inventors, artists, educators and composers.

As your interest in stamp collecting grows, you will find it advisable to add to your knowledge of this hobby. You will find much useful information in the many books about stamps. A necessary item for collectors is Scott's Standard Postage Stamp Catalogue, which we have already mentioned. Perhaps you can persuade your parents to buy you a copy of this fine work for your birthday or as a Christmas present.

By the time that you have a really good collection, you will be calling yourself a philatelist (pronounced fih-lat′-eh-list). A philatelist is a collector who has really become a student of stamps. The collection and study of stamps is called philately (pronounced fih-lat′-eh-lee). You will often come upon these words in works that deal with the subject of stamps. There are many such books.

There are many other technical terms with which



Stamps which, like these, picture animals and birds of different lands make a most fascinating collection.

you will become acquainted as your interest in stamp collecting grows, and you become a real philatelist. Definitions of a good many of these terms will be found in some of the books dealing with stamp collecting. The more common terms are defined in Scott's STANDARD POSTAGE STAMP CATALOGUE.

The finer your own collection of postage stamps is, the more you will want to know about the collections of other philatelists. You will probably want to join a stamp club in your home town. At club headquarters you will be able to talk about your favorite hobby with other fans. You will show them your treasures and they will be glad to show you theirs. There are a great many stamp clubs all over the world; some of them have members in number of countries.

Article prepared by Charlotte N. Downs, managing editor of STAMPS, THE MAGAZINE OF PHILATELY.

TWIN SWEATERS FOR YOU TO KNIT

IN this article we shall show you how to knit twin sweaters, a cardigan and a pullover. The directions given in this article are for size 12. It will be well to read over first the general instructions for knitting which accompany the article on How to Knit a Child's Sock. (See Index, under Knitting.) These instructions are illustrated. They show you how to hold your knitting needles and cast on stitches. They also give directions for knitting and purling, for making or increasing the number of stitches on your needles and for decreasing.

For the cardigan and pullover which are described here, you will need five skeins of 3¾-ounce Utopia knitting worsted, 8 buttons and a yard of ribbon. You will also need a Columbia bone crochet hook, size 3, and a pair of Columbia celluloid or Boye non-inflammable needles, size 8.

There are just two stitches in this set, plain knitting and stockinette, which is knit 1, purl 1. The border and the yoke are plain knitting, the body of each sweater is in stockinette. 4 stitches make an inch. 8 rows of plain knitting make an inch. 6 rows of stockinette knitting make an inch.

THE CARDIGAN

Back of Cardigan

Let us start with the back of the cardigan. You will be working from the bottom, toward the neck. First you are to cast on 52 stitches. Knit 3 inches plain. Change to stockinette, on next row. Increase 1 stitch in every 5th stitch, then increase 1 stitch in every 6th stitch, until you have 60 stitches on your needle. Continue knit 1, purl 1 until the work measures 10¾ inches.

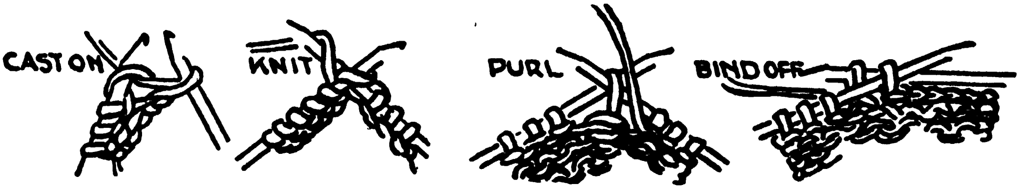
Now you are ready to form the armhole of the cardigan. You are to begin by binding off 2 stitches at the beginning of the next 4 rows. Fifth row, decrease 1 stitch at each end. Sixth row, do not decrease. Seventh row, decrease 1 stitch at each end. Stop and count your stitches; there should be 48 in all. Knit 1, purl 1 without decreasing until the work is 3 inches from the beginning of the armhole.

This is where you begin the yoke. Change to plain knitting. Work until you are 6 inches from beginning of armhole.

Now for the shoulder of the cardigan. Begin by binding off 5 stitches at the start of the next six rows. Bind off the remaining 18 stitches. Put this piece (the back of the cardigan) aside until the rest of the garment is finished and you are ready at last to sew the pieces together.

Left Front of Cardigan

Cast on 28 stitches. Knit 3 inches. Now change to stockinette stitch (knit 1, purl 1). Increase 1 stitch in every 4 stitches in the next row until you have 34 stitches on your



Stitches used in making the twin sweaters described in this article.

needle. (That means that you have increased 6 times in the row.) Knit 1, purl 1 until the work measures 10¾ inches.

For the armhole, bind off 2 stitches at the armhole edge, twice, then decrease 1 stitch at this side, every other row, twice. Now you have 28 stitches on your needle. Knit 1, purl 1 until the work is 3 inches from the beginning of the armhole.

For the yoke, you must change to plain knitting. Work until 5 inches from the beginning of the armhole.

Shoulder and neck shaping. Bind off 5 stitches at neck edge, then decrease 1 stitch at neck edge every row for 6 rows. Bind off 5 stitches at shoulder edge 3 times. Decrease 1 stitch at neck edge in next 2 rows. Bind off remaining stitches.

For right front of cardigan, work the same as the left, reversing the shaping, and working buttonholes. This is the way to make them. After you have knitted ½ inch, knit 2 stitches from front edge. Bind off 2 stitches. Next row, cast on 2 stitches over the 2 bound-off stitches. Make 7 more buttonholes, 2½ inches apart.

Sleeve

For the sleeve, cast on 26 stitches. Knit for 2½ inches. Change to stockinette. In next row increase 1 stitch in every 6th stitch across the row, until you have increased 4 stitches. Increase 1 stitch each side in every 1¾ inches, until you have increased 14 more stitches. Now you have 44 stitches on your needle. Knit 1, purl 1 until 16 inches from beginning.

For the sleeve cap, bind off 2 stitches at the beginning of the next 2 rows, then decrease 1 stitch each side every other row 5 times, then every row 12 times. Bind off the remaining 6 stitches.

Make the other sleeve just like this.

Sewing Parts Together

Now you are ready to sew your cardigan together. Sew the two fronts to the back at the underarm seams. Sew the shoulder seams together. Sew the sleeves up. Insert them in the armholes, having the seams meet at the underarm. Work one row of single crochet around the entire jacket. Face the front edges with ribbon. Sew on the buttons and overcast the buttonholes. In sewing up the seams, it is best to pin them loosely first, so that there will be no danger of the material puckering.

THE PULLOVER

For the back, cast on 48 stitches. Knit plain 3 inches. Then change to stockinette. Increase 1 stitch in every 6th stitch across the row, until you have added 8 stitches. Now you have 56 stitches in all on your needle. Knit 1, purl 1 until you are 10 inches from the beginning.

For the armhole, bind off 2 stitches at the beginning of the next 2 rows. Decrease 1 stitch each side every other row twice, which will leave 48 stitches on your needle. Knit 1, purl 1 until 3 inches from the beginning of the armhole. For the yoke you are to change to plain knitting. Work until 6 inches from the beginning of the armhole. For the shoulder, bind off 3 stitches at beginning of next 4 rows. Then bind off 4 stitches at beginning of next 2 rows. Bind off remaining 28 stitches.

The completed twin sweaters.

The front is made exactly like the back.

Sleeves of Pullover

You will want short sleeves on the pullover. Cast on 36 stitches. Knit plain 1½ inches. Change to stockinette. Increase 1 stitch in each 9th stitch across the row, until you have increased 4 stitches. Now increase 1 stitch each side every 4th row, twice. Work 44 stitches even, until 4 inches from beginning of sleeve.

For the sleeve cap, bind off 2 stitches at the beginning of the next 2 rows, then decrease 1 stitch at the beginning of each side every other row five times, then every row 12 times. Bind off remaining stitches.

Make the other sleeve to correspond.

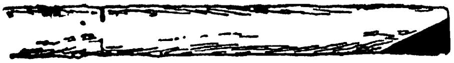
Sewing the Pullover Together

Now you are ready to sew your pullover together. First you are to sew up the front and the back at the underarm seams and at the shoulders. Then sew up the sleeves and insert them in the armholes. You should be sure that the seams meet exactly at the underarms. Finally work one row of single crochet around the neck.

Your twin sweaters are now completed and are ready to be worn.

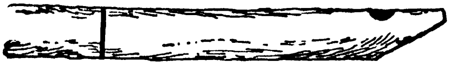
A WHISTLE THAT A BOY CAN MAKE

IT is very easy to make the little whistle that we describe in this article. All we need is a sharp jackknife and a twig from a green sycamore or willow tree. We should select a twig that has smooth bark and that is as nearly round as possible. Cut off a five-inch length; then cut a slanting piece off at one end, as seen in Figure 1. The black area shows the part to be removed. This will be the lip of our little whistle.



1. First stage.

Now we make a notch at the top side of the lip, as shown in Figure 2. We then cut a ring around the bark only, down near the other end of the piece of wood. Next we moisten the bark by placing it in water. Using the knife like a little hammer, we beat the bark gently all around with the handle of the knife, moistening the bark several times as we do so.

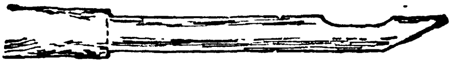


2. Second stage.

After a while we shall find that the bark can be slipped right off in one piece from the ring that we made. The surface of the stick, when we have removed the bark in this way will be smooth with a transparent and somewhat sticky fluid adhering to it. This fluid is the sap of the tree.

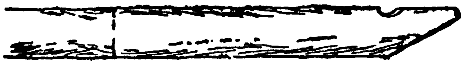
We wipe off the sap. Then with the knife we enlarge the notch that we have made by cutting away a piece of the wood furthest from the lip or pointed end. Figure 3 shows the piece that is to be cut away. Now we cut a very thin strip from the upper surface of the stick between the notch and the pointed end. Finally we replace the bark that we removed in one piece. Our whistle is now completed (see Figure 4).

It should give a shrill, clear note when we blow into it. If it does not work well, it may be because we did not enlarge the notch enough or because we cut away too much. Experiment with another piece of wood until you have a satisfactory whistle.



3. Third stage.

If you succeed in making a whistle with a satisfactory tone, you may become more ambitious and you may want to make another whistle that gives several notes of the scale. For this larger instrument we need a longer twig, say about ten inches long. Before loosening the bark, we must make a series of round holes that extend farther down the stick. Then, when we have removed the bark, we must extend the notch right down past all the round holes. The different notes of the whistle are produced by first covering the holes with our fingers and then lifting up each finger in turn. You will find out by experience how far apart the holes should be made to produce the correct musical intervals.



4. The completed whistle.

THE MARKED PENNY TRICK

HERE is a simple trick which will puzzle your friends. It consists of picking a marked penny out of a cap without seeing it. First of all you borrow a cap, and then you ask three or four members of the audience to put a penny each into it. We next cover the cap with a hankerchief, taking as much time as possible in doing so.

We now ask any member of the audience to take one of the coins from the hat, and to put a light mark on it with pencil. He then passes it around to the other members of the audience, so that they may see where the mark is and thus recognize the penny when they see it again. After this, the one who marked the penny is to return it to the cap and to cover the cap with the handkerchief.

Now it is time for us to perform the trick. We put our hand into the cap, under the handkerchief, and without any hesitation we draw out the marked coin.

Here is the explanation. In marking the penny, one member of the audience handled it for several seconds. The coin was also handled by the other members of the audience who examimed it. Now the heat of all these hands was passed on to the penny. When we feel the coins in the hat, the warmth of the one that was handled is noticeable. So we are able to identify it without trouble.

THE GAME OF MARBLES

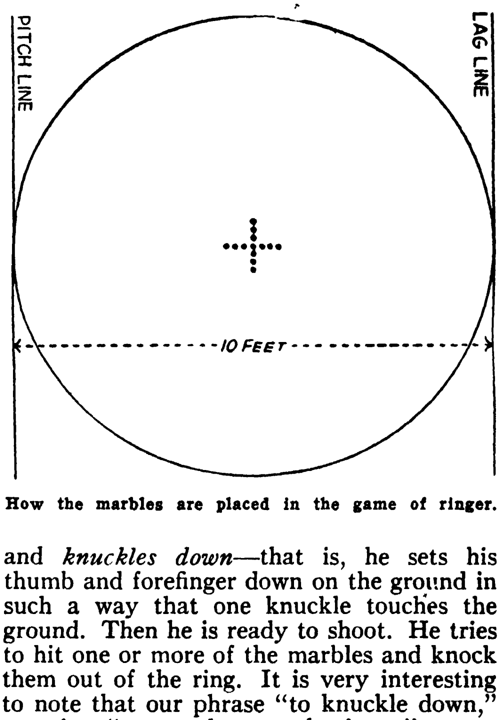
AT the first signs of spring, when winter snows have disappeared from the ground, boys and girls all over the world bring out their marbles for a game which is nearly as old is is man himself. Marble games differ widely from country to country, and sometimes even from district to district. However, a few of these games are much the same everwhere, though rules and methods may differ somewhat here and there.

The official national marbles tournament game in North America is known as *ringer.* It is played in a circle ten feet in diameter, with thirteen marbles or *mibs,* arranged in in the center in such a way as to form a cross. One marble is placed in the middle of the circle, and the others are lined up three inches apart, as shown in the diagram that we give on this page.

Two to six players may join in the game at one time, except in national championship matches, when only two may play. Before play begins, the players *lag* in order to see which will go first. The pitch and lag lines shown in the diagram are used for this purpose. Each player in turn toes the pitch line and tosses or shoots his own marble, or shooter, so that it may come to rest as near to the lag line as possible. The player whose marble lands nearest to the lag line has the first turn in the game. Other players follow according to the nearness of their shooters to the lag line.

The object of ringer is to shoot the marbles out of the ring. The player stands at any point on the ring line, places his shooter between his thumb and forefinger and *knuckles down*—that is, he sets his thumb and forefinger down on the ground in such a way that one knuckle touches the ground. Then he is ready to shoot. He tries to hit one or more of the marbles and knock them out of the ring. It is very interesting to note that our phrase "to knuckle down," meaning "to get down to business," comes from this shot in the game of ringer.

If the player knocks one or more marbles out of the ring and his shooter remains in it, he is entitled to another shot from the spot where the shooter has come to rest. He continues to shoot until he fails to knock a marble out of the ring or until his shooter



How the marbles are placed in the game of ringer.

goes out of it. When a player's turn has ended, he picks up his shooter and awaits his next turn. The other players shoot in order. The one who knocks most marbles out of the ring is the winner.

Another game of marbles is called *nine holes,* though in actual play there may be more or less than nine holes. A row of small pits is dug in the ground; the game consists of tossing or bowling the marbles into each hole in succession. The player who does this in the fewest number of turns wins the game. As a variation of this game, the marbles may be knocked into the holes with a shooter. If this is done, the shooter must not follow the marble into the hole, or the player misses his turn.

There is one game of marbles which, it is thought, was invented by country school children, who played it on their way to early morning classes. It is called *hit and span.* The first player—let us call him A tosses his marble to a distance. Player B then tries to throw his marble as near to the first as possible. If he hits it, he may keep it, scoring one. He also scores one if he comes within a span, or handbreadth, of his opponent's marble. Whether or not B scores a point, he now throws his marble and player A tries to hit it. The one who scores the most points is the winner of the game.

Marble games need not necessarily be played out of doors. In bad weather a playroom floor may serve just as well as the ground does on sunny days. If Mother lets you make chalk marks on the floor, the games are played just as they are out of doors. (Of course, nine holes is out of the question!) A favorite indoor marble game is one in which the players sit on the floor. One of these players spreads his legs out and places a marble between his feet; another player shoots at the marble from a distance.

SNAP—AN EXCITING CARD GAME

YOU will find this game great fun. An ordinary pack of playing cards is used. Any number of players may take part; the more the merrier. First of all, each player chooses a card from the pile, which is placed face downward, and the one who has the highest card serves as the dealer. The dealer does not play himself but merely deals out the cards and later serves as the umpire, as we shall see.

The cards are all dealt out, face downward, to the players and no player looks at his cards. The player sitting on the left-hand side of the dealer begins by turning over the top card of his heap and placing it face upward on the table some distance in card being turned up is the same kind of cards. The next player on the first player's left does the same with the top card of his pile, and so on around the table; one player after another turns his top card face upward, so that all may see.

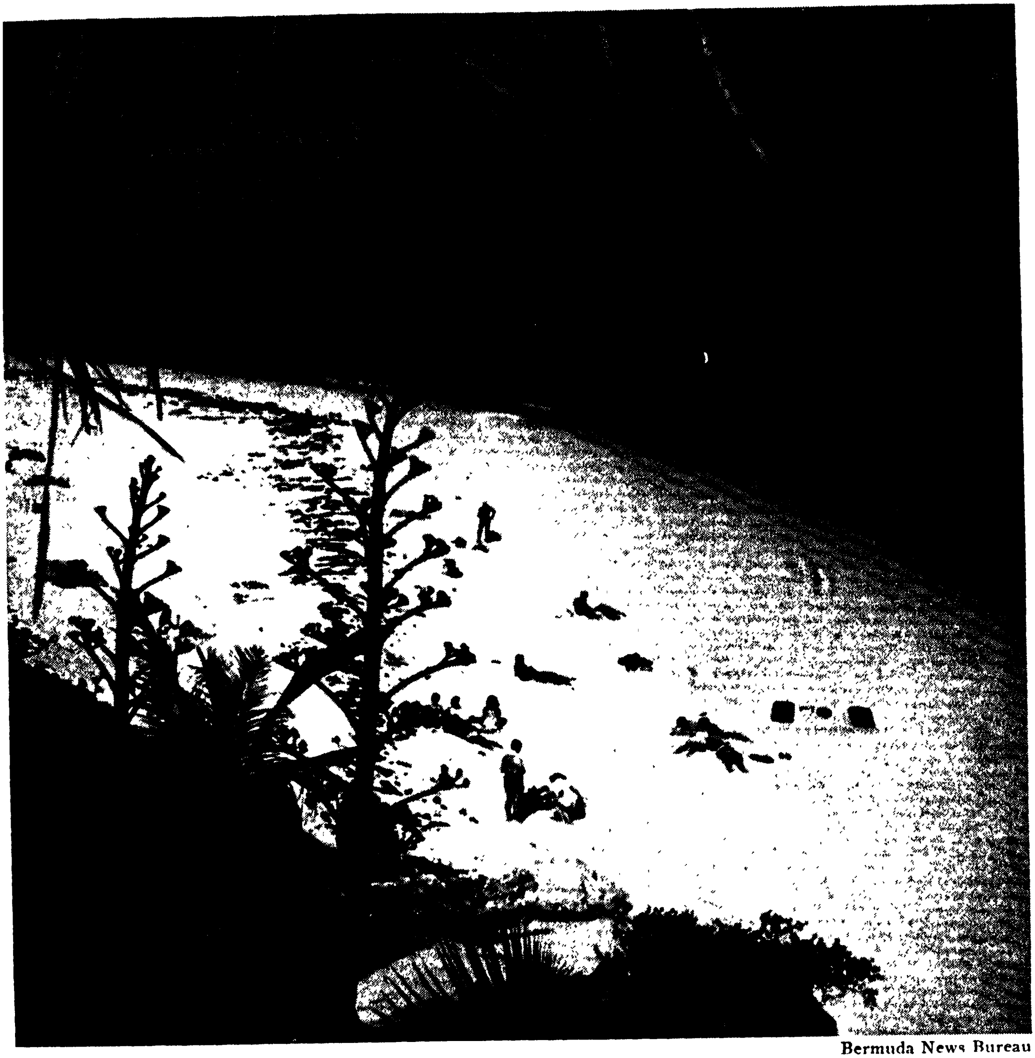
While the cards are being turned up in this way, if any player notices that the card being turned up is the same kind of card—a king, say, or a queen or a ten—as the uppermost exposed card in front of his own pile, he calls out "Snap!" Whichever of the players with similar cards says "Snap" first takes all the up-turned cards in front of the other player, and puts them beneath his upturned heap. The umpire decides which one of the players spoke first. The game then goes on. As the heaps of turned-up cards grow, every time that a player acquires a heap of cards, he adds a great deal to his own heap. If all of a player's cards are taken away, he is out of the game. The other players, of course, continue to play as before.

If the player who is turning up a card calls out "Snap" by mistake, he must put all the cards in his pile of turned-up cards in a special pile of so-called *dead cards.* These cards must not be used again in this particular hand. If any other player in the game calls out "Snap" by mistake, he must forfeit his turned-up cards to the player who has just turned up the card.

As the game proceeds, one player after another loses all his cards, until finally there are only two players left in the game. These two go on until one of them succeeds in winning all the cards of the other player, when the game is at an end.

In playing the second game, the player to the left of the first dealer now becomes dealer in his turn. He deals out the cards and then serves as umpire, just as the first dealer had done. The latter becomes one of the players in the game.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 5593.



Bermuda News Bureau

How Did the Sand Get on the Seashore?

THE sand found on the shore or anywhere else is made up of ground rocks. Most of this rock material is sandstone, which is largely a compound of two elements, oxygen and silicon. You know that in the world of living things carbon is a very common element. Silicon is one of the most common elements in the non-living world; and like carbon it combines very readily with another common element, oxygen.

Ages ago, when the earth was cooling down and forming a crust, a great deal of silicon combined with oxygen, in a compound that we call silica. Tiny grains of silica became glued together by means of softer substances to form sandstone. This is not a very hard stone. Wind and water grind it down into grains of various sizes. Then we call it sand. Some sand comes from the breaking down of other rocks; but most of it is silica.

National Film Board

There is great power in the irresistible ebb and flow of the tides, though little used. However, coastal fishermen mark the tides well, else their boats at anchor would be left stranded on the beach when the tide goes out.

CAN WE MAKE THE TIDES WORK FOR US?

For a very long time men have been trying to find some way of making use of the rising and falling of the sea in the daily tides. It is possible to use the tides only where the difference in the level at high and low water is very great, as in the case on the southwest coast of England, the northwest coast of France, and on the north German coast, and on the eastern coast of the United States.

In England, at the mouth of the Severn River the difference between high and low water at the spring tides, when sun and moon are pulling together in the same direction, is 42 feet, and at the neap tides, when sun and moon are opposing one another, 21 feet. This was the spot suggested for the first experiment in the harnessing of the tides. The scheme for harnessing the power of the tides in the Severn Estuary includes a great dam built across the mouth of the river, with a channel and locks for the passage of ships. Sluice-doors would admit the water when the tide was rising. At the turn of the tide the doors would be closed in order to imprison the water above the dam. Then this would be let out gradually, working turbines as it ran away. When more power was being produced than was needed, this would be used to pump up water to a still higher level, where it would remain till more power was wanted than was being produced. Then this water would be let out to work additional turbines. In this way the great problem of storing power would be solved economically. The power produced by this harnessing of the tides in the Severn would, it is believed, save three or four million tons of coal a year, a very large amount of fuel indeed.

At Rockland, Maine, there is a 5,000 horse-power electric plant that uses tidal water for compressing air. This then serves instead of steam to drive an engine. In the Bay of Fundy, between Nova Scotia and New Brunswick, the tidal rise is almost 40 feet. Engineers say that by building a three-mile sea wall across a narrow gap, electric power a hundred times greater than that from Niagara could be obtained.

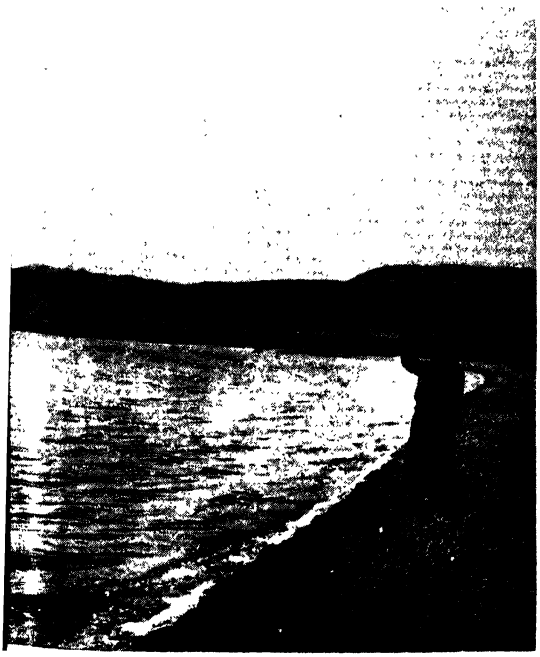
WHAT IS A TIDAL WAVE?

When we speak of a tidal wave, we do not refer to the regular flow and ebb of the tide. We have in mind the huge waves caused by violent winds or by earthquakes.

Unusually strong winds cause the waters of the ocean to come storming against the land in mighty waves. Tidal waves caused by earthquakes are even more terrible. When an earthquake takes place under the surface of the sea, the waters above the spot are violently stirred. A great wave is then set in motion. As it sweeps along into shallow water, it destroys everything in its path. Sometimes an earthquake on the coast causes a tidal wave. The waters near the coast are flung seaward; then they return in a solid wall. The port of Callao, in Peru, was entirely destroyed in 1746 by an earthquake and the tidal wave that followed.

WHY CAN'T FISH LIVE IN THE DEAD SEA?

The Dead Sea was first so named by the great writer Jerome because no form of animal life is found in it. This can readily be explained when we study the composition of the water. It would, in the first place, be difficult or impossible for a fish to keep under water—which is as necessary for fish as it is for us to keep above water—in the Dead Sea, so dense is the water, owing to the salt. And, in the second place, the salts found in the water include some that are powerfully antiseptic, or fatal to life, particularly the lower forms. The water actually contains 3 per cent of the salt called calcium chloride, which is very poisonous to all forms of life. More than half the salt of the Dead Sea consists of magnesium chloride. Its composition is thus very different indeed from that of ordinary sea water.



Ewing Galloway

The gravelly shore of the strange Dead Sea.

WHAT CAUSES THE CHANGE IN COLOR OF THE SEA?

On a black night, when there is no light for the sea to reflect, the sea looks black. When the sky is gray, the sea reflects the light that falls on it and looks gray. We usually think of the sea as blue, because the sky is often blue, and the sea reflects the blue.

Yet sometimes the sea is green, though the sky is never green. Why is this? Parts of the sea are shallow, especially near the shore. They may be so shallow that some of the light from the sky may pierce the water, reach the bottom and be reflected from it to our eyes. So, of course, the light will be changed, partly according to the color of the bottom of the sea, and partly because the sea water a little ways down is not able to transmit the red rays of light; and so the water looks green.

Besides all this, we have to remember that the same part of the sea may be of a different color on different days, even though the water is the same and the color of the bottom is the same. There are many different things that affect the color of the sea: whether the sun is clouded over, the time of day and other conditions.

WHAT MAKES THE CURRENTS THAT FLOW THROUGH THE SEA?

A current is not the same thing as a wave, which, though it seems to move onward, is really due to the water's moving up and down. After the wave has passed, the water is in the same place as it was before. But in the case of a current, the water is actually moving from one place to another. There is a lake in Switzerland through which a river runs, and by the difference in the color of the water you can see where the river is. Here, the water of the river is falling to the sea, which is lower down than the place where the river started. It is really the earth's attraction that is pulling the water of the river through the lake and making the current.

In the sea, currents are due to something that is pulling or pushing part of the water through the rest of the water. These currents may be due to various causes. Sometimes it may be a steady wind blowing for some time in one direction, driving some of the water before it. More often, perhaps, currents are due to differences in the heat of the water. Warm water in cold water will keep to itself, so to speak, and will move through the sea. The Gulf Stream is an example. If the sun shines brightly on a particular part of the sea it makes the water there hotter and so may start a current. Indeed, the currents of water in the sea are often due to very much the same causes as the currents in the air.

IS EVERY SEVENTH WAVE A BIGGER ONE?

No. It is pure superstition that says that every third or every seventh or every ninth wave, when the tide comes in, is bigger than the others. It is untrue and without any basis of fact. There are many old superstitions about three and seven and nine. These have come to us from long ago, when those numbers were thought to have some special value.

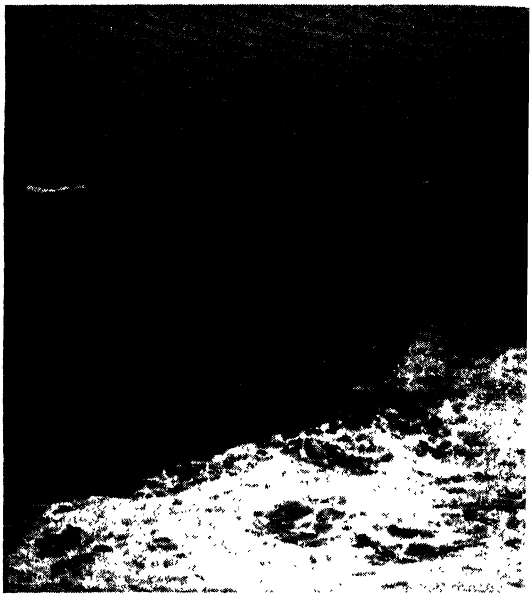
HOW MANY OCEANS ARE THERE?

There is really only one ocean and it covers between two-thirds and three-quarters of the earth's surface. However, the continents divide it into three great parts, the Pacific, the Atlantic and the Indian oceans, and we generally mean one of these when we use the word ocean.

These three oceans flow together around the South Pole, and sometimes that part is called the Antarctic Ocean. The Atlantic and Pacific are also often divided into northern and southern sections. Finally, the enclosed sea around the North Pole is often called the Arctic Ocean. Many geography books give all these seven different oceans, and we often call them "the seven seas."

WHY IS IT THAT THE SEA DOES NOT FREEZE?

Sea water, like any other kind of water, can freeze, and it does freeze if the conditions are right; but there are some good reasons why the sea does not freeze nearly so easily as a pond or lake, or a river. The salt in sea water makes some difference.



More important is the depth and constant motion of sea water. Until the whole depth of a quantity of water has been cooled it can not begin to freeze; for until it has all cooled, the warmer water, being lighter, must always come to the top. Therefore, when water is very deep, it is very difficult to freeze.

The sea is in constant movement under the influence of tides and winds and currents. The motion of water interferes very much with its freezing, though not nearly so much as the depth.

But in the coldest parts of the earth's surface the sea does freeze, as for instance, around the North and South Poles. The same seems to be the case on our near neighbor, the planet Mars, for we can see through our telescopes what look like ice or snow caps at each of its poles.

WHAT MAKES THE SEA ROAR?

Though sound can travel in all kinds of matter, it is usually, as we know it, a wave in the air. This is true when we hear the sea roaring. Everywhere the surface of the water is in contact with the air, and if the water moves violently, it may start in the air those waves that our ears can hear and that we call sound.

These waves are of low frequency, as we say. That is, they are comparatively few

Ewing Galloway, N. Y.

per second. Such waves make sounds of low pitch. Sometimes, when a wave breaks, a great volume of water may fall upon the rest of the water, and so make a sound more like an explosion than a roar.

Tennyson wrote once about what he called "the scream of the maddened beach"; and it is very interesting to notice that we do hear on the beach sounds that are much more like a scream than like a roar. In this case, it is the action of the water on the beach, and not the water directly, that makes the scream, and the kind of scream will depend on the kind of beach. Where there are pebbles of certain kinds, as the waves move up and down they rub the pebbles against each other, and that produces airwaves of a quicker rate (higher frequency), which may be likened to a scream.

WHY IS THE SEA NEVER STILL?

There are some times when the sea is nearly still, though no doubt even when it looks like glass, there are waves in it too small for us to see. But the sea is almost always moving, and it moves because the air above it is moving.

If there were no wind, the sea would slowly swell up and fall again, owing to the tides made by the moon. It would do this very quietly, so that if you looked just for a moment you would notice nothing. But the waves are made by the wind. It is true that the sea may have great waves though there is no wind, but those waves were raised by the wind somewhere else. They may have traveled hundreds of miles to reach our eyes.

Only a short distance below the surface the sea is quiet. If you could see the water not many feet down, during the greatest storm, when the waves on the surface are mountainous, you would find it quite still.

HOW MUCH WATER IS THERE IN THE SEA?

Most of us know that about three-fourths of the whole surface of the earth is covered with water. If now we could learn the average depth of the sea all over the world, it would need only multiplication to answer this question.

We find great variations in the depth of the oceans—places where the highest mountain might be buried, and great shallow areas, too; but the latest result of an enormous number of soundings taken in every part of the sea, except at and round the poles, is that the average depth of the oceans all the world over is a little under two and a half miles. This is probably a great deal deeper than you would have thought, and it means a rather long multiplication if you want to learn the number of cubic miles. Scientists have estimated the amount of water in the sea at 323,722,000 cubic miles.

WHERE AND WHAT IS THE SARGASSO SEA?

The Sargasso Sea is a part of the North Atlantic Ocean between about 25 to 35 degrees North Latitude and 40 to 70 degrees West Longitude. It is a vast oval-shaped area extending from about 500 miles east of Florida and the West Indies out into the middle of the Atlantic. It is a rather still body of water, enclosed by the North Equatorial Current, the Gulf Stream and the Gulf Stream Drift, a branch of the Gulf Stream that turns south instead of continuing to northern Europe. The sea is named for the masses of floating seaweed, sargasso weed, that drift over its surface. This seaweed grows in deep water along warm coasts, but it is easily detached and strong currents will carry it far out to sea. You can see the same effect in a swiftly flowing stream; bits of plants and other material are carried along by the stream's current and slowly accumulate in the calm patches of water near the banks.

The sargasso weed floats by means of tiny grape-like bladders—*sargo* is a Portuguese word for a kind of grape. As the currents are always moving, the masses of the weed in the Sargasso Sea are constantly being renewed.

There are similar areas in all the oceans, but the Sargasso Sea is the largest and the most lasting, and by far the best known. It was reported by Columbus on his first voyage. His ships were involved in it for several days. At one time superstitious sailors believed that ships might become enmeshed in it without being able to escape.

American Museum of Natural History

The graceful sargasso weed. Tiny grape-like bladders keep it afloat near the surface of the sea.

Many legends grew up about it. Some people believed that the lost continent of Atlantis lay hidden beneath the floating weed. Others believed that a vast number of treasure ships, Spanish galleons filled with gold, were caught fast in the sea. All such stories have been proved false. Observers flying in airplanes over this part of the ocean have seen no ships imprisoned in seaweed, and no indications of a buried continent.

IS THERE GOLD IN THE SEA?

Gold is one of the substances that we should not expect to find in sea water, but we do find it there in quite recognizable quantity. If we consider the enormous bulk of the sea, the total quantity of gold in it must be considerable. Yet it is not enough to repay the cost of getting it out, and no one does so except chemists, who work for love of science and not for love of gold.

WHY DOESN'T SEA WATER MAKE FISHES THIRSTY?

We might almost answer this question by another: How do we know that fishes are not thirsty? It is not at all easy to find out how much water fishes drink; but, like every living thing, they require water, and perhaps take a good deal.

We do not find that the muscles of a fish contain higher proportions of salts than the muscles of other animals; nor can we show any particular difference between the quantity of salts in the body of a fresh-water fish compared with the body of a salt-water fish. We know that many fishes travel from fresh to salt water, and from salt to fresh, and they are able to adapt themselves to different kinds of water. This can only mean that the organs of the body that are concerned with keeping the composition of the blood right are able, when occasion requires, to filter an excess of salts out of it very quickly. The same is true of our own bodies, fortunately for us, as we often take food and drink containing an excess of various substances that certainly must not stay long in the blood. On the other hand, we are not adapted to keep the composition of the blood right if we drink nothing but sea water, as fishes can do without harm.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5613.

British Poetry of the 19th Century

Part I

Illustrated by Elinore Blaisdell

The Harp That Once Through Tara's Halls

By THOMAS MOORE (1779-1852)

The harp that once through Tara's halls
The soul of music shed,
Now hangs as mute on Tara's walls,
As if that soul were fled.
So sleeps the pride of former days,
So glory's thrill is o'er,
And hearts, that once beat high for praise,
Now feel that pulse no more.

No more to chiefs and ladies bright
The harp of Tara swells;
The chord alone, that breaks at night,
Its tale of ruin tells.
Thus Freedom now so seldom wakes,
The only throb she gives,
Is when some heart indignant breaks,
To show that she still lives.

A Thing of Beauty

From ENDYMION

By JOHN KEATS (1795-1821)

A thing of beauty is a joy for ever:
Its loveliness increases; it will never
Pass into nothingness; but still will keep
A bower quiet for us, and a sleep
Full of sweet dreams, and health, and quiet breathing.
Therefore, on every morrow, are we wreathing
A flowery band to bind us to the earth,
Spite of despondence, of the inhuman dearth
Of noble natures, of the gloomy days,
Of all the unhealthy and o'er-darkened ways
Made for our searching: yes, in spite of all,
Some shape of beauty moves away the pall
From our dark spirits. Such the sun, the moon,
Trees old and young, sprouting a shady boon
For simple sheep; and such are daffodils
With the green world they live in; and clear rills
That for themselves a cooling covert make
'Gainst the hot season; the mid-forest brake,
Rich with a sprinkling of fair musk-rose blooms:
And such too is the grandeur of the dooms
We have imagined for the mighty dead;
All lovely tales that we have heard or read:
An endless fountain of immortal drink,
Pouring unto us from the heaven's brink.

The Isles of Greece

From DON JUAN

By LORD BYRON (1788-1824)

The isles of Greece! the isles of Greece!
Where burning Sappho loved and sung,
Where grew the arts of war and peace,
Where Delos rose, and Phoebus sprung!
Eternal summer gilds them yet,
But all, except their sun, is set.

The mountains look on Marathon—
And Marathon looks on the sea;
And musing there an hour alone,
I dreamed that Greece might still be free;
For standing on the Persians' grave,
I could not deem myself a slave.

A king sate on the rocky brow
Which looks o'er sea-born Salamis;
And ships, by thousands, lay below,
And men in nations;—all were his!
He counted them at break of day—
And when the sun set, where were they?

Must *we* but weep o'er days more blest?
Must *we* but blush?—Our fathers bled.
Earth! render back from out thy breast
A remnant of our Spartan dead!
Of the three hundred grant but three,
To make a new Thermopylae!

Ode on a Grecian Urn

By JOHN KEATS (1795-1821)

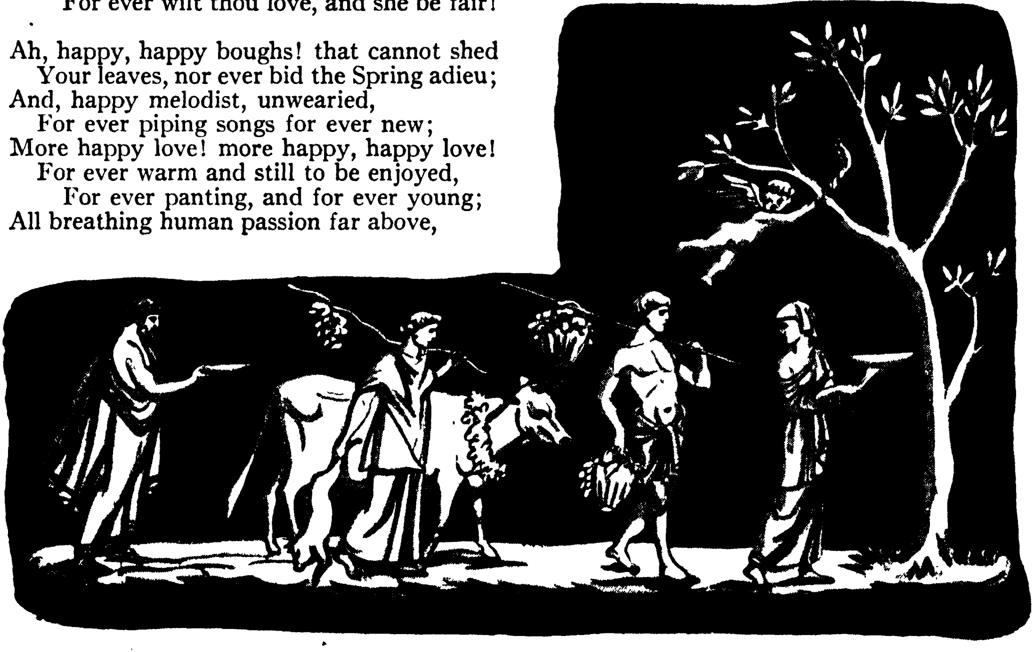
THOU still unravished bride of quietness,
Thou foster-child of silence and slow time,
Sylvan historian, who canst thus express
A flowery tale more sweetly than our rime:
What leaf-fringed legend haunts about thy shape
Of deities or mortals, or of both,
In Tempe or the dales of Arcady?
What men or gods are these? What maidens loth?
What mad pursuit? What struggle to escape?
What pipes and timbrels? What wild ecstasy?

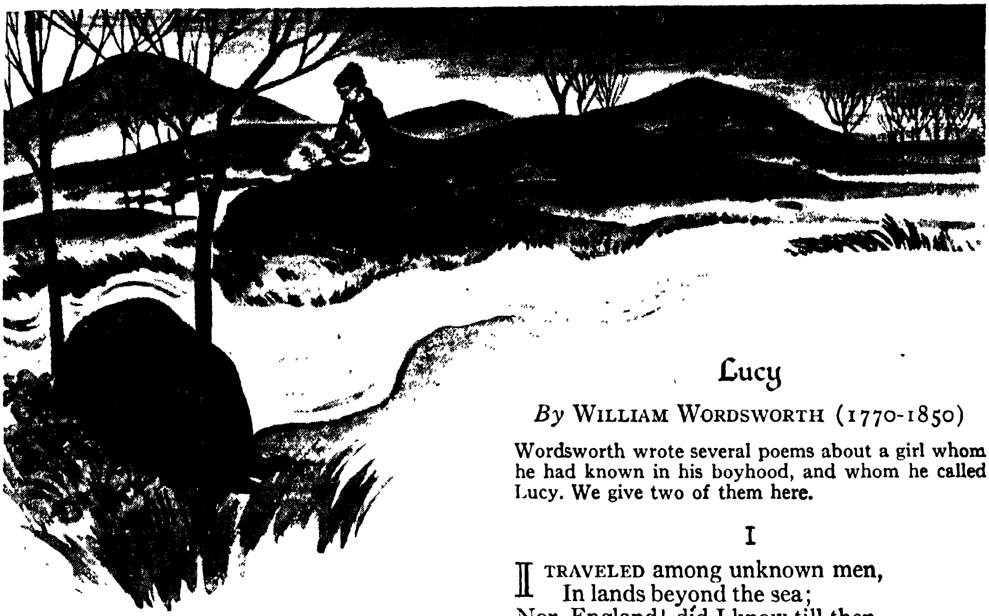
Heard melodies are sweet, but those unheard
Are sweeter; therefore, ye soft pipes, play on;
Not to the sensual ear, but, more endeared,
Pipe to the spirit ditties of no tone:
Fair youth, beneath the trees, thou canst not leave
Thy song, nor ever can those trees be bare;
Bold Lover, never, never canst thou kiss,
Though winning near the goal—yet do not grieve;
She cannot fade, though thou hast not thy bliss,
For ever wilt thou love, and she be fair!

Ah, happy, happy boughs! that cannot shed
Your leaves, nor ever bid the Spring adieu;
And, happy melodist, unwearied,
For ever piping songs for ever new;
More happy love! more happy, happy love!
For ever warm and still to be enjoyed,
For ever panting, and for ever young;
All breathing human passion far above,
That leaves a heart high-sorrowful and cloyed,
A burning forehead, and a parching tongue.

Who are these coming to the sacrifice?
To what green altar, O mysterious priest,
Lead'st thou that heifer lowing at the skies,
And all her silken flanks with garlands dressed?
What little town by river or sea shore,
Or mountain-built with peaceful citadel,
Is emptied of its folk, this pious morn?
And, little town, thy streets for evermore
Will silent be; and not a soul to tell
Why thou art desolate, can e'er return.

O Attic shape! Fair attitude! with brede
Of marble men and maidens overwrought,
With forest branches and the trodden weed;
Thou, silent form, dost tease us out of thought
As doth eternity: Cold Pastoral!
When old age shall this generation waste,
Thou shalt remain, in midst of other woe
Than ours, a friend to man, to whom thou say'st,
"Beauty is truth, truth beauty,"—that is all
Ye know on earth, and all ye need to know.





Music, When Soft Voices Die

By Percy Bysshe Shelley
(1792-1822)

Music, when soft voices die,
Vibrates in the memory—
Odors, when sweet violets sicken,
Live within the sense they quicken.

Rose leaves, when the rose is dead,
Are heaped for the belovèd's bed;
And so thy thoughts, when thou art
gone,
Love itself shall slumber on.

Verses to Ianthe

By Walter Savage Landor
(1775-1864)

I

From you, Ianthe, little troubles pass
Like little ripples down a sunny river;
Your pleasures spring like daisies in the
grass,
Cut down, and up again as blithe as ever.

II

Past ruined Ilion Helen lives;
Alcestis rises from the shades.
Verse calls them forth; 'tis verse that gives
Immortal youth to mortal maids.

Lucy

By William Wordsworth (1770-1850)

Wordsworth wrote several poems about a girl whom he had known in his boyhood, and whom he called Lucy. We give two of them here.

I

I traveled among unknown men,
In lands beyond the sea;
Nor, England! did I know till then
What love I bore to thee.

'Tis past, that melancholy dream!
Nor will I quit thy shore
A second time; for still I seem
To love thee more and more.

Among thy mountains did I feel
The joy of my desire;
And she I cherished turned her wheel
Beside an English fire.

Thy mornings showed, thy nights
concealed
The bowers where Lucy played;
And thine too is the last green field
That Lucy's eyes surveyed.

II

She dwelt among the untrodden ways
Beside the springs of Dove,
A maid whom there were none to praise
And very few to love:

A violet by a mossy stone
Half hidden from the eye.
—Fair as a star, when only one
Is shining in the sky.

She lived unknown, and few could know
When Lucy ceased to be;
But she is in her grave, and, oh,
The difference to me!

The Well of St. Keyne

By ROBERT SOUTHEY (1774-1843)

A WELL there is in the west country,
  And a clearer one never was seen;
There is not a wife in the west country
  But has heard of the Well of St. Keyne.

An oak and an elm tree stand beside,
  And behind doth an ash-tree grow,
And a willow from the bank above
  Droops to the water below.

A traveler came to the Well of St. Keyne;
  Joyfully he drew nigh;
For from cock-crow he had been traveling,
  And there was not a cloud in the sky.

He drank of the water so cool and clear,
  For thirsty and hot was he,
And he sat down upon the bank,
  Under the willow-tree.

There came a man from the house hard by,
  At the Well to fill his pail,
On the Well-side he rested it,
  And bade the traveler hail.

"Now, art thou a bachelor, Stranger?" quoth he,
  "For, an if thou hast a wife,
The happiest draught thou hast drank this day
  That ever thou didst in thy life.

"Or has thy good woman, if one thou hast,
  Ever here in Cornwall been?
For, an if she have, I'll venture my life
  She has drunk of the Well of St. Keyne."

"I have left a good woman who never was here,"
  The Stranger he made reply;
"But that my draught should be better for that,
  I pray you answer me why."

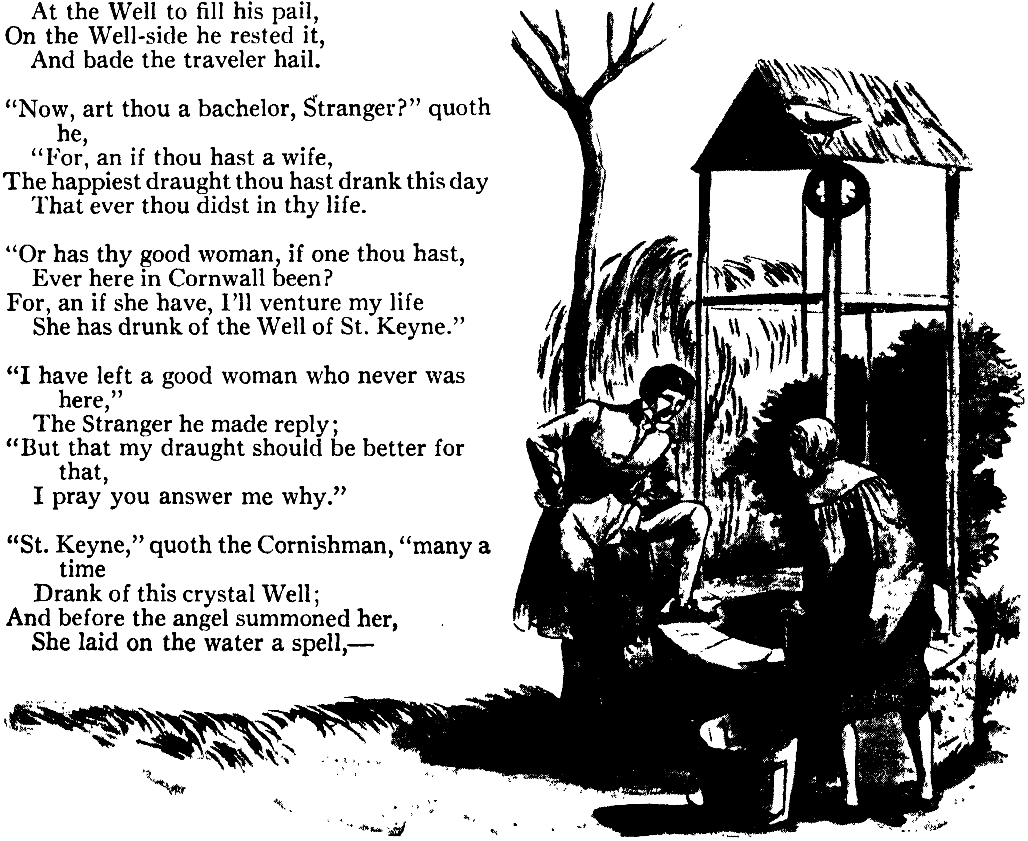
"St. Keyne," quoth the Cornishman, "many a time
  Drank of this crystal Well;
And before the angel summoned her,
  She laid on the water a spell,—

"If the Husband, of this gifted Well
  Shall drink before his Wife,
A happy man henceforth is he,
  For he shall be Master for life;—

"But, if the Wife should drink of it first,
  Heaven help the Husband then!"—
The Stranger stooped to the Well of St. Keyne,
  And drank of the water again.

"You drank of the Well, I warrant, betimes?"
  He to the Cornishman said;
But the Cornishman smiled as the Stranger spake,
  And sheepishly shook his head:—

"I hastened, as soon as the wedding was done,
  And left my Wife in the porch;
But i' faith, she had been wiser than me,
  For she took a bottle to church."



She Walks in Beauty

By Lord Byron (1788-1824)

She walks in beauty, like the night
Of cloudless climes and starry skies;
And all that's best of dark and bright
Meet in her aspect and her eyes;
Thus mellowed to that tender light
Which heaven to gaudy day denies.

One shade the more, one ray the less,
Had half impaired the nameless grace
Which waves in every raven tress,
Or softly lightens o'er her face;
Where thoughts serenely sweet express
How pure, how dear their dwelling-place.

And on that cheek, and o'er that brow,
So soft, so calm, yet eloquent,
The smiles that win, the tints that glow,
But tell of days in goodness spent,
A mind at peace with all below,
A heart whose love is innocent!

The War-Song of Dinas Vawr

From THE MISFORTUNES OF ELPHIN

By Thomas Love Peacock (1785-1866)

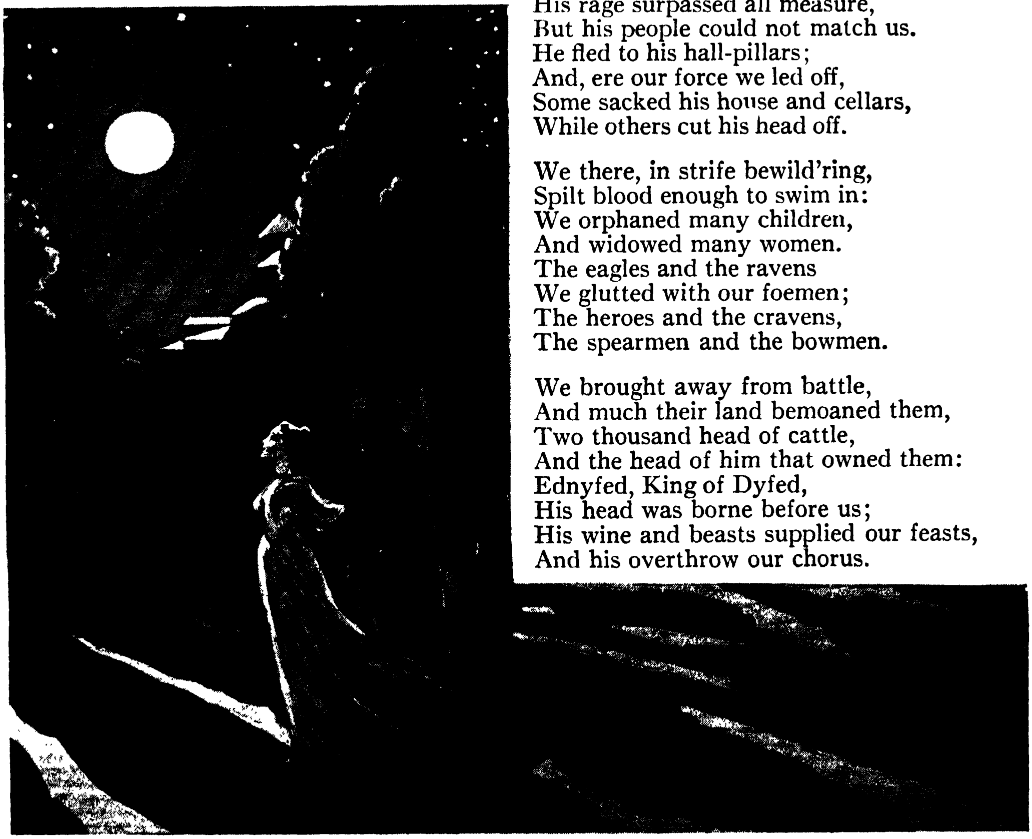
The mountain sheep are sweeter,
But the valley sheep are fatter;
We therefore deemed it meeter
To carry off the latter.
We made an expedition;
We met a host, and quelled it;
We forced a strong position,
And killed the men who held it.

On Dyfed's richest valley,
Where herds of kine were brousing,
We made a mighty sally,
To furnish our carousing.
Fierce warriors rushed to meet us;
We met them, and o'erthrew them:
They struggled hard to beat us;
But we conquered them, and slew them.

As we drove our prize at leisure,
The king marched forth to catch us:
His rage surpassed all measure,
But his people could not match us.
He fled to his hall-pillars;
And, ere our force we led off,
Some sacked his house and cellars,
While others cut his head off.

We there, in strife bewild'ring,
Spilt blood enough to swim in:
We orphaned many children,
And widowed many women.
The eagles and the ravens
We glutted with our foemen;
The heroes and the cravens,
The spearmen and the bowmen.

We brought away from battle,
And much their land bemoaned them,
Two thousand head of cattle,
And the head of him that owned them:
Ednyfed, King of Dyfed,
His head was borne before us;
His wine and beasts supplied our feasts,
And his overthrow our chorus.



Waterloo

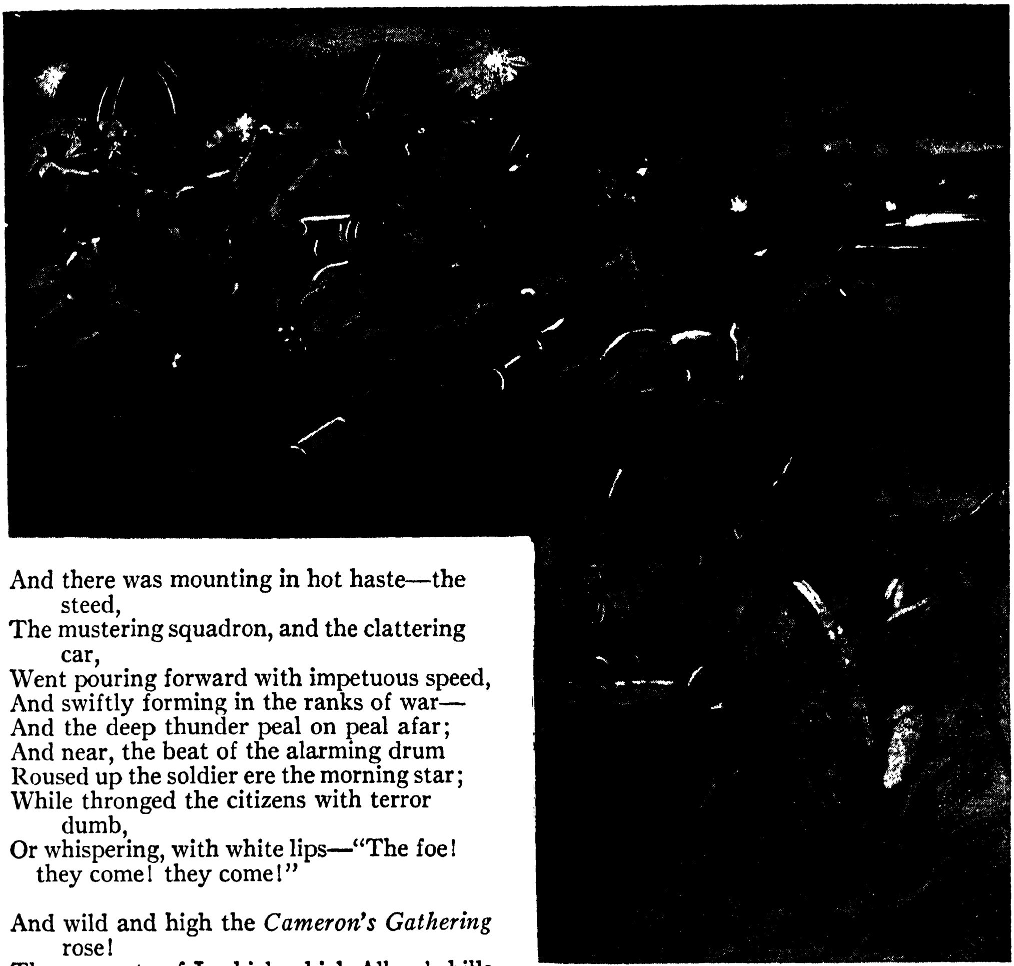
From CHILDE HAROLD'S PILGRIMAGE

By LORD BYRON (1788-1824)

THERE was a sound of revelry by night,
And Belgium's capital had gathered then
Her Beauty and her Chivalry, and bright
The lamps shone o'er fair women and brave men;
A thousand hearts beat happily; and when
Music arose with its voluptuous swell,
Soft eyes looked love to eyes which spake again,
And all went merry as a marriage bell;
But hush! hark! a deep sound strikes like a rising knell!

Did ye not hear it?—No; 'twas but the wind,
Or the car rattling o'er the stony street;
On with the dance! let joy be unconfined;
No sleep till morn, when Youth and Pleasure meet
To chase the glowing Hours with flying feet—
But hark!—that heavy sound breaks in once more,
As if the clouds its echo would repeat;
And nearer, clearer, deadlier than before!
Arm! Arm! it is—it is—the cannon's opening roar!
Within a windowed niche of that high hall
Sat Brunswick's fated chieftain; he did hear
That sound the first amidst the festival,
And caught its tone with Death's prophetic ear;
And when they smiled because he deemed it near,
His heart more truly knew that peal too well
Which stretched his father on a bloody bier,
And roused the vengeance blood alone could quell;
He rushed into the field, and, foremost fighting, fell.

Ah! then and there was hurrying to and fro,
And gathering tears, and tremblings of distress,
And cheeks all pale, which but an hour ago
Blushed at the praise of their own loveliness;
And there were sudden partings, such as press
The life from out young hearts, and choking sighs
Which ne'er might be repeated; who could guess
If ever more should meet those mutual eyes,
Since upon night so sweet such awful morn could rise!



And there was mounting in hot haste—the steed,
The mustering squadron, and the clattering car,
Went pouring forward with impetuous speed,
And swiftly forming in the ranks of war—
And the deep thunder peal on peal afar;
And near, the beat of the alarming drum
Roused up the soldier ere the morning star;
While thronged the citizens with terror dumb,
Or whispering, with white lips—"The foe! they come! they come!"

And wild and high the *Cameron's Gathering* rose!
The war-note of Lochiel, which Albyn's hills
Have heard, and heard, too, have her Saxon foes:—
How in the noon of night, that pibroch thrills,
Savage and shrill! But with the breath which fills
Their mountain-pipe, so fill the mountaineers
With the fierce native daring which instills
The stirring memory of a thousand years,
And Evan's—Donald's—fame rings in each clansman's ears!

And Ardennes waves above them her green leaves,
Dewy with Nature's tear-drops as they pass,
Grieving, if aught inanimate e'er grieves,
Over the unreturning brave,—alas!
Ere evening to be trodden like the grass
Which now beneath them, but above shall grow
In its next verdure, when this fiery mass
Of living valor, rolling on the foe
And burning with high hope shall molder cold and low.

Last noon beheld them full of lusty life,
Last even in Beauty's circle proudly gay,
The midnight brought the signal-sound of strife,
The morn the marshalling in arms,—the day
Battle's magnificently stern array!
The thunder-clouds close o'er it, which when rent
The earth is covered thick with other clay,
Which her own clay shall cover, heaped and pent,
Rider and horse,—friend, foe,—in one red burial blent!

THE NEXT POEMS ARE ON PAGE 5707.

The Cobblers and the Cuckoo

A TALE FROM GRANNY'S WONDERFUL CHAIR

By FRANCES BROWNE

ONCE upon a time there stood in the middle of a cold, bleak moor, in the far North Country, a certain village; all its inhabitants were poor, for their fields were barren, and they had little trade. But the poorest of them all were two brothers called Scrub and Spare, who followed the cobbler's craft, and had but one stall between them. It was a hut built of clay and wattles. There they worked in most brotherly friendship, though with little encouragement.

The people of that village were not extravagant in shoes, and better cobblers than Scrub and Spare might be found. Nevertheless, Scrub and Spare managed to live by means of their trade, a small barley field and a cottage garden, till one unlucky day when a new cobbler arrived in the village. He had lived in the capital city of the kingdom, and, by his own account, cobbled for the queen and the princesses. His awls were sharp, his lasts were new; he set up his stall in a neat cottage with two windows.

The villagers soon found out that one patch of his would outwear two of the brothers'. In short, all the mending left Scrub and Spare and went to the new cobbler. So the brothers were poor that winter, and when Christmas came they had nothing to feast on but a barley loaf, a piece of musty bacon and some small beer of their own brewing. However, they made a great fire of logs, which crackled and blazed with red embers, and in high glee the cobblers sat down to their beer and bacon. The door was shut, for there was nothing but cold moonlight and snow outside; but the hut, strewn with fir boughs, and ornamented with holly, looked cheerful as the ruddy blaze flared up and rejoiced their hearts.

"Long life and good fortune to ourselves, brother!" said Spare. "I hope you will drink that toast, and may we never have a worse fire on Christmas—but what is that?"

Spare set down the drinking-horn, and the brothers listened astonished, for out of the blazing-stump they heard "Cuckoo! cuckoo!" as plain as ever the spring bird's voice came over the moor on a May morning.

"It is something bad," said Scrub, terribly frightened.

"Maybe not," said Spare.

And out of the deep hole at the side which the fire had not reached flew a large gray cuckoo, and lit on the table before them. Much as the cobblers had been surprised, they were still more so when the bird began to speak.

"Good gentlemen," it said slowly, "can you tell me what season this is?"

"It's Christmas," answered Spare.

"Then a merry Christmas to you!" said the cuckoo. "I went to sleep in the hollow of that old stump one evening last summer, and never woke till the heat of your fire made me think it was summer again; but now, since you have burned my lodging, let me stay in your hut till the spring comes round—I want only a hole to sleep in—and when I go on my travels next summer be assured that I will bring you some present for your trouble."

"Stay, and welcome," said Spare. "I'll make you a good warm hole in the thatch. But you must be hungry after that long sleep. Here is a slice of barley bread. Come, help us to keep Christmas!"

The cuckoo ate up the slice, drank water from the brown jug—for he would take no beer—and flew into a snug hole which Spare scooped for him in the thatch of the hut. So the snow melted, the heavy rains came, the cold grew less, the days lengthened, and one sunny morning the brothers were awakened by the cuckoo shouting its call to let them known that at last the spring had come.

"Now," said the bird, "I am going on my travels over the world to tell men of the spring. There is no country where trees bud or flowers bloom that I will not cry in before the year goes round. Give me another slice of barley bread to keep me on my journey, and tell me what present I shall bring you at the end of the twelve months."

"Good Master Cuckoo," said Scrub, "a diamond or a pearl would help such poor men as my brother and I to provide something better than barley bread for your next entertainment."

"I know nothing of diamonds or pearls," said the cuckoo; "they are in the hearts of rocks and in the sands of rivers. My knowledge is only of that which grows on the earth. But there are two trees hard by the well that lies at the world's end. One of them is called the golden tree, for its leaves are all of beaten gold. As for the other, it is always green, like a laurel. Some call it the wise, and some the merry tree. Its leaves never fall, but they that get one of them keep blithe hearts in spite of all misfortunes, and can make themselves as merry in a poor hut as in a handsome palace."

"Good Master Cuckoo, bring me a leaf off that tree!" cried Spare.

"Now, brother, don't be foolish!" said Scrub. "Think of the leaves of beaten gold! Dear Master Cuckoo, bring me one of them."

Before another word could be spoken the cuckoo had flown.

The brothers were poorer than ever that year; nobody would send them a single shoe to mend. The new cobbler said, in scorn, that they should come to be his apprentices; and Scrub and Spare would have left the village but for their barley field, their cabbage garden and a maid called Fairfeather, whom both the cobblers had courted for more than seven years.

At the end of the winter Scrub and Spare had grown so poor and ragged that Fairfeather thought them beneath her notice. Old neighbors forgot to invite them to wedding feasts or merrymakings; and they thought the cuckoo had forgotten them too, when at daybreak, on the first of April, they heard a hard beak knocking at their door, and a voice crying: "Cuckoo! cuckoo! Let me in."

Spare ran to open the door, and in came the cuckoo, carrying on one side of his bill a golden leaf, larger than that of any tree in the North Country; and on the other, one like that of the common laurel, only it had a fresher green.

"Here!" it said, giving the gold to Scrub and the green to Spare.

So much gold had never been in the cobbler's hands before, and he could not help exulting over his brother.

"See the wisdom of my choice," he said, holding up the large leaf of gold. "As for yours, as good might be plucked from any hedge. I wonder a sensible bird should carry the like so far."

"Good Master Cobbler," cried the cuckoo, finishing the slice, "your conclusions are more hasty than courteous. If your brother be disappointed this time, I go on the same journey every year, and, for your hospitable entertainment, will think it no trouble to bring each of you whichever leaf you desire."

"Darling Cuckoo," cried Scrub, "bring me a golden one."

And Spare, looking up from the green leaf on which he gazed, said: "Be sure to bring me one from the merry tree."

And away flew the cuckoo once again on his travels over the world.

Scrub vowed that his brother was not fit to live with a respectable man; and taking his lasts, his awls and his golden leaf, he left the wattle hut and went to tell the villagers.

They were astonished at the folly of Spare, and charmed with Scrub's good sense, particularly when he showed them the golden leaf, and told them that the cuckoo would bring him one every spring. The new cobbler immediately took him into partnership; the greatest people sent him their shoes to mend; Fairfeather smiled graciously upon him, and in the course of that summer they were married, with a grand wedding feast at which the whole village danced, except Spare, who was not invited.

As for Scrub, he established himself with Fairfeather in a cottage close by that of the new cobbler, and quite as fine. There he mended shoes to everybody's satisfaction, had a scarlet coat for holidays and a fat goose for dinner every wedding anniversary.

Spare lived on in the old hut and worked in the cabbage garden. Every day his coat grew more ragged, and the hut more weather-beaten; but people remarked that he never looked sad or sour; and the wonder was that, from the time they began to keep his company, the tinker grew kinder to the poor ass with which he traveled the country, the beggar-boy kept out of mischief and the old woman was never cross to her cat or angry with the children.

I know not how many years had passed in this manner when a certain great lord, who owned that village, came to the neighborhood. His castle was ancient and strong, with high towers and a deep moat. All the country, as far as one could see from the highest turret, belonged to this lord; but he had not been there for twenty years, and would not have come then, only he was melancholy.

The cause of his grief and sorrow was that he had been prime minister at court, and in high favor, till somebody told the crown prince that he had spoken disrespectfully concerning the turning out of His Royal Highness's toes, whereon the North Country lord was turned out of office and banished to his own estate. There he lived for some weeks in a very bad temper; but one day in the harvest time his lordship chanced to meet Spare gathering water-cresses at a meadow stream, and fell into talk.

How it was nobody could tell, but from the hour of that discourse the great lord cast away his melancholy, and went about with a noble train, making merry in his hall, where all travelers were entertained and all the poor were welcome.

This strange story soon spread through the North Country, and a great company came to the cobbler's hut—rich men who had lost their money, poor men who had lost their friends, beauties who had grown old, wits who had gone out of fashion—all came to talk with Spare, and, whatever their troubles, all went home merry. The rich gave him presents, the poor gave him thanks.

By this time his fame had reached the court. There were a great many discontented people there besides the King, who had lately fallen into ill humor because a neighboring princess, with seven islands for her dowry, would not marry his eldest son. So a royal messenger was sent to Spare, with a command that he should go to court.

"To-morrow is the first of April," said Spare, "and I will go with you two hours after sunrise."

The messenger lodged all night at the hut, and the cuckoo came at sunrise with the merry leaf.

"Court is a fine place," he said, when the cobbler told him he was going; "but I can not go there—they would lay snares and catch me. So be careful of the leaves I have brought you, and give me a farewell slice of barley bread."

Spare was sorry to part with the cuckoo, but he gave him a thick slice, and, having sewed up the leaves in the lining of his leathern doublet, he set out with the messenger on his way to the royal court.

His coming caused great surprise; but His Majesty had conversed with him scarcely half an hour when the princess and her seven islands were forgotten, and orders given that a feast for all comers should be spread in the banquet hall. The princes of the blood, the great lords and ladies, ministers of state and judges of the land after that discoursed with Spare, and the more they talked the lighter grew their hearts, so that such changes had never been seen.

As for Spare, he had a chamber assigned him in the palace, and a seat at the King's table; one sent him rich robes and another costly jewels; but in the midst of all his grandeur he still wore the leathern doublet, which the palace servants thought remarkably mean. One day, the King's attention being drawn to it by the chief page, His Majesty inquired why Spare didn't give it to a beggar. But the cobbler said: "High and mighty monarch, this doublet was with me before silk and velvet came—I find it easier to wear than the court cut; moreover, it serves to keep me humble, by recalling the days when it was my holiday garment."

The King thought this a wise speech, and commanded that no one should find fault with the leathern doublet. So things went, and Spare prospered.

PART II

He was treated like a prince at the King's court; and the news of his good fortune reached his brother Scrub in the moorland cottage one first of April, when the cuckoo came again with two golden leaves.

"Think of that!" said Fairfeather. "Here we are spending our lives in this humdrum place, and Spare making his fortune at court with two or three paltry green leaves! What would they say to our golden ones? Let us make our way to the King's palace."

Scrub thought this excellent reasoning. So, putting on their holiday clothes, Fairfeather took her looking-glass and Scrub his drinking-horn, which happened to have a very thin rim of silver, and, each carrying a golden leaf carefully wrapped up that none might see it till they reached the palace, the pair set out in great expectation.

How far Scrub and Fairfeather journeyed I can not say, but when the sun was high and warm at noon they came into a wood feeling both tired and hungry.

"Let us rest ourselves under this tree," said Fairfeather, "and look at our golden leaves to see if they are quite safe."

In looking at the leaves and talking of their fine prospects, Scrub and Fairfeather did not perceive that a very thin old woman had slipped from behind the tree, with a long staff in her hand and a great wallet by her side.

"Noble lord and lady," she said, "will ye condescend to tell me where I may find some water to mix with a bottle of mead which I carry in my wallet, because it is too strong for me?"

As the old woman spoke she pulled out a large wooden bottle such as shepherds used in ancient times, corked with leaves rolled together, and having a small wooden cup hanging from its handle.

"Perhaps ye will do me the favor to taste," she said. "It is only made of the best honey. I have also cream cheese and a wheaten loaf here, if such honorable persons as you would not think it beneath you to eat the like."

Scrub and Fairfeather became very condescending after this speech. They were now sure that there must be some appearance of nobility about them; besides, they were very hungry, and having hastily wrapped up the golden leaves, they assured the old woman that they were not at all proud, notwithstanding the lands and castles they had left behind them in the North Country, and would willingly help to lighten the wallet.

The old woman was a wood-witch; her name was Buttertongue; and all her time was spent in making mead, which, being boiled with curious herbs and spells, had the power of making all who drank it fall asleep and dream with their eyes open. She had two dwarfs for sons; one was named Spy, and the other Pounce. Wherever their mother went they were not far behind; and whoever tasted her mead was sure to be robbed by the dwarfs.

Scrub and Fairfeather sat leaning against the old tree. The cobbler had a lump of cheese in his hand; his wife held fast a hunch of bread. The eyes and mouths of both were open, but they were dreaming of great grandeur at court, when the old woman raised her shrill voice: "What ho, my sons! Come here, and carry home the harvest!"

No sooner had she spoken than the two little dwarfs darted out of the neighboring thicket.

"Idle boys!" cried the mother. "What have you done to-day to help our living?"

"I have been to the city," said Spy, "and could see nothing. These are hard times for us—everybody minds his business so contentedly since that cobbler came. But here is a leathern doublet which his page threw out of the window; it's of no use, but I

brought it to let you see I was not idle." And he tossed down Spare's doublet with the merry leaves in it, which he had been carrying like a bundle on his little back.

To explain how Spy came by it, it must be said that the forest was not far from the great city where Spare lived in such high esteem. All things had gone well with the cobbler till the King thought that it was quite unbecoming to see such a worthy man without a servant. His Majesty therefore appointed one of his own pages to wait upon him. The name of this youth was Tinseltoes, and nobody in all the court had grander notions. Nothing could please him that had not gold or silver about it, and his grandmother feared he would hang himself for being appointed page to a cobbler. As for Spare, the honest man had been so used to serve himself that the page would have been always in the way, but his merry leaves came to his assistance.

Tinseltoes took wonderfully to the new service. Some said it was because Spare gave him nothing to do but play at bowls all day on the palace green. Yet one thing grieved the heart of Tinseltoes, and that was his master's leathern doublet, and at last, finding nothing else would do, the page got up one fine morning earlier than his master, and tossed the leathern doublet out of the window into a lane, where Spy found it.

"That nasty thing!" said the old woman. "Where is the good in it?"

By this time Pounce had taken everything of value from Scrub and Fairfeather — the looking-glass, the silver-rimmed horn, the husband's scarlet coat, the wife's gay mantle, and, above all, the golden leaves, which so rejoiced old Buttertongue and her sons that they threw the leathern doublet over the sleeping cobbler for a jest, and went off to their hut in the heart of the forest.

The sun was going down when Scrub and Fairfeather awoke from dreaming that they had been made a lord and a lady, and sat clothed in silk and velvet, feasting with the King in his palace hall. It was a great disappointment to find their golden leaves and all their best things gone. Scrub tore his hair, and vowed to take the old woman's life; while Fairfeather lamented sore. But Scrub, feeling cold for want of his coat, put on the leathern doublet without asking whence it came.

Scarcely was it buttoned on when a change came over him. He addressed such merry discourse to Fairfeather that, instead of lamenting, she made the wood ring with laughter. Both busied themselves in setting up a hut of boughs, in which Scrub kindled a fire with flint and steel, which, together with his pipe, he had brought unknown to Fairfeather, who had told him the like was never heard of at court. Then they found a pheasant's nest at the root of an old oak, made a meal of roasted eggs, and went to sleep on a heap of long green grass which they had gathered, with nightingales singing all night long in the old trees about them.

In the meantime Spare had got up and missed his doublet. Tinseltoes, of course, said he knew nothing about it. The whole palace was searched, and every servant questioned, till all the court wondered why such a fuss was made about an old leathern doublet. That very day things came back to their old fashion. Quarrels began among the lords, and jealousies among the ladies. The King said his subjects did not pay him half enough taxes, the Queen wanted more jewels, the servants took to their old bickerings and got up some new ones. Spare found himself getting wonderfully dull and very much out of place, and the nobles began to ask what business a cobbler had at the King's table. At last His Majesty issued a decree banishing the cobbler forever from court, and confiscating all his goods in favor of Tinseltoes.

The royal edict was scarcely published before the page was in full possession of Spare's rich chamber, his costly garments and all the presents the courtiers had given him; while Spare was glad to make his escape out of the back window, for fear of the angry people.

The window from which Spare let himself down with a strong rope was that from which Tinseltoes had tossed the doublet, and as the cobbler came down late in the twilight, a poor woodman, with a heavy load of fagots, stopped and stared in astonishment.

"What's the matter, friend?" said Spare. "Did you never see a man coming down from a back window before?"

"Why," said the woodman, "the last morning I passed here a leathern doublet came out of that window, and I'll be bound you are the owner of it."

"That I am, friend," said the cobbler with great eagerness. "Can you tell me which way that doublet went?"

"As I walked on," the woodman said, "a dwarf called Spy bundled it up and ran off into the forest."

Determined to find his doublet, Spare went on his way, and was soon among the tall trees; but neither hut nor dwarf could he see. At last, when he was on the point of giving up, the red light of a fire, gleaming through a thicket, led him to the door of a low hut. It stood half open, as if there was nothing to fear, and within he saw his brother Scrub snoring loudly on a bed of grass, at the foot of which lay his own beloved leathern doublet; while Fairfeather, in a scarlet kirtle, sat roasting pheasants' eggs by the fire.

"Good evening, mistress!" said Spare.

The blaze shone on him, but so changed was her brother-in-law with his court life that Fairfeather did not know him, and she answered far more courteously than was her wont.

"Good evening, master! Whence come ye so late? But speak low, for my good man has sorely tired himself cleaving wood, and is taking a sleep, as you see, before supper."

"A good rest to him," said Spare, perceiving he was not known to her, "I come from the court for a day's hunting, and have lost my way in the forest."

"Sit down and have a share of our supper," said Fairfeather; "I will put some more eggs in the ashes; and while they are roasting tell me the news of court."

"Did you never go there?" said the cobbler. "So fair a dame as you would make the ladies marvel."

"You are pleased to flatter," said Fairfeather; "but my husband has a brother there, and we left our moorland village to try our fortune also. An old woman enticed us with fair words and strong drink at the entrance of this forest, where we fell asleep and dreamed of great things; but when we woke everything had been taken from us, and in place of everything the robbers left him that old leathern doublet, which he has worn ever since, and never was so merry in all his life, though we live in this poor hut without any possessions."

"It is a shabby doublet, though," said Spare, taking up the garment, and seeing that it was his own, for the merry leaves were still sewed in its lining. "It would be good for hunting in, however. Your husband would be glad to part with it, I dare say, in exchange for this handsome cloak." And he pulled off the green mantle and buttoned on the doublet, much to Fairfeather's delight, for she shook Scrub, crying: "Husband, husband, rise and see what a good bargain I have made!"

Scrub rubbed his eyes, gazed up at his brother and said: "Spare, is that really you? How did you like the court, and have you made your fortune?"

"That I have, brother," said Spare, "in getting back my own good leathern doublet. Come, let us eat eggs, and rest ourselves here this night. In the morning we will return to our own old hut, at the end of the moorland village, where the Christmas cuckoo will come and bring us leaves every year as before. That will be better than courts."

Scrub and Fairfeather agreed. So in the morning they returned, and found the old hut little the worse for wear and weather. The neighbors came about them to ask the news of court and to see if they had made their fortune. Everybody was astonished to find the three poorer than ever, but somehow they liked to be back in the hut. Spare brought out the lasts and awls he had hidden in a corner; Scrub and he began their old trade, and the whole North Country found out that there never were such cobblers. Everybody wondered why the brothers had not been more appreciated before they went away to the court of the King, but, from the highest to the lowest, all were glad to have Spare and Scrub back again.

They mended the shoes of lords and ladies as well as the common people; everybody was satisfied. Their custom increased from day to day, and all that were disappointed, discontented or unlucky came to the hut as in old times, before Spare went to court.

The hut itself changed, no one knew how. Flowering honeysuckle grew over its roof; red and white roses grew thick about its door. Moreover, the Christmas cuckoo always came on the first of April, bringing three leaves of the merry tree—for Scrub and Fairfeather would have no more golden ones. So it was with them when I last heard the news of the North Country.

Meanwhile at the court matters went from bad to worse. The King and Queen quarreled daily, with each other, with the courtiers and with the servants. Tinseltoes became so conceited that the King chased him away from the palace. The taxes went up until the people groaned under the burden. Indeed, it was a very trying time. Everyone sighed for the good old peaceful days. Yet it is strange that no one realized that all the evils followed the expulsion of Spare the cobbler, and they never learned the truth.

The Prince Who Was Poor

ADAPTED FROM THE FAIRY TALE *by* HANS CHRISTIAN ANDERSEN

THERE was once a poor Prince who had a kingdom. His kingdom was very small, but still quite large enough to marry upon; and he wished to marry.

It was certainly presumptuous of him to ask the Emperor's daughter to marry him. But so he did; for his name was renowned far and wide.

It happened that where the Prince's father lay buried there grew a rose tree—a most beautiful rose tree, which blossomed only once in every five years, and even then bore only one flower, but that *was* a rose! It smelled so sweet that all cares and sorrows were forgotten by him who inhaled its fragrance.

The Prince also had a nightingale which sang as though all the sweet melodies in the world had a dwelling in its little throat. These the Prince prized above all other possessions, and so he placed them in two silver caskets and sent them to the Princess.

The Emperor had them brought into a large hall, where the Princess was playing with the ladies of the court; and when she saw the caskets she clapped her hands for joy.

"Ah, if there were but a little pussy-cat in one of the caskets!" she exclaimed; but just then the rose tree, with its beautiful rose, came to view.

The Princess touched it, and was ready to cry from disappointment; then she pushed it away.

"Let us see what is in the other casket," proposed the Emperor. So the nightingale came forth, and sang so delightfully that at first no one could say anything ill-humored of it. Everyone but the Princess was charmed.

"I hope that it is not a real bird," said the Princess.

"Yes, it is a real bird," said those who had brought it. "Well, then, let the bird fly," returned the Princess; and she positively refused to see the Prince.

However, he was not easily discouraged. He was determined to see her, so he daubed his face with brown and black, pulled his cap over his ears, and knocked at the door.

"Good day to my lord the Emperor," he said, "Can I have employment at the palace?"

"Why, yes," said the Emperor; "I want someone to take care of the pigs, of which we have a great many."

So the Prince was appointed imperial swineherd. He had a dirty little room close by the pigsty, and there he sat the whole day and worked. By the evening he had made a pretty little saucepan. Little bells were hung all around it; and while the pot was boiling these bells tinkled merrily, and played an old melody.

But, what was still more curious, whoever held his finger in the steam from this saucepan smelled the dishes that were cooking on every hearth in the city.

Now, the Princess happened to walk that way, and when she heard the tune she stood quite still, and seemed pleased, for she could play this old tune—it was the only piece she knew.

"Why, there is my piece," said the Princess; "that swineherd must certainly have been well educated. Ask him the price of the instrument."

So one of the court ladies ran in.

"What will you take for the saucepan?" inquired the lady.

"I will have ten kisses from the Princess," said the swineherd.

"Indeed!" said the lady.

"Well, what does he say?" asked the Princess.

"I can not tell you," replied the lady; "it is too bad!"

"Then you can whisper it!" So the lady whispered it.

"He is an impudent fellow!" said the Princess, and she walked on. But when she had gone a little way the bells tinkled so prettily that she stopped.

"Ask him if he will have ten kisses from my companions," said she.

"No, thank you!" answered the swineherd; "ten kisses from the Princess, or I keep the saucepan myself."

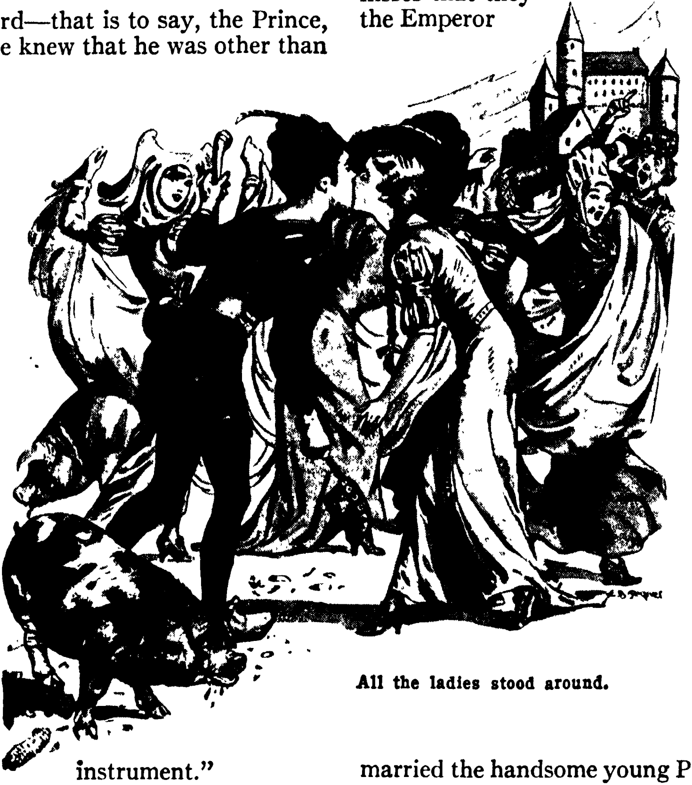
"That must not be, either," said the Princess; "but do you all stand before me, that no one may see us."

The court ladies placed themselves in front of her, and spread out their dresses, and the swineherd took ten kisses, and the Princess the saucepan.

That was delightful. The saucepan was kept boiling all the evening, and the whole of the following day. They knew perfectly well what was cooking at every fire in the city, from the chamberlain's to the cobbler's. The court ladies danced and clapped their hands.

"We know who has soup and who has pancakes for dinner to-day, who has cutlets and who has eggs. How interesting!" said the court ladies.

The swineherd—that is to say, the Prince, although no one knew that he was other than an ill-favored swineherd — let not a day pass without working at something. At last he constructed a rattle which, when it was swung in the owner's hand, played all the waltzes and jig-tunes which had ever been heard in all the countries of the world.



All the ladies stood around.

"Ah, that is wonderful!" said the Princess, when she passed by. "Ask him the price of the instrument."

"A hundred kisses from the Princess," said the young lady when she returned.

"I think he is not in his right senses," replied the Princess, and walked on; she determined not to think about it, but when she had gone a little way she stopped. "Tell him he shall have ten kisses from me, and the rest from you."

"Oh, but we should not like that at all!" they said.

"What are you muttering?" asked the Princess. "If I can kiss him, surely you can!"

So the young ladies were obliged to go to him again.

"A hundred kisses from the Princess!" he said.

"Stand around!" said the Princess; and all the ladies stood around while the swineherd kissed the Princess.

"What can be the reason for such a crowd close by the pigsty?" said the Emperor, who happened just then to step out on the balcony. "I must go down to see what they are about!"

When he reached the courtyard he moved very softly, and the ladies were so much engrossed with counting the kisses that they did not see the Emperor approaching.

"What is all this?" he said, when he saw what was going on; and he boxed the Princess's ears, just as the swineherd was taking the eighty-sixth kiss.

"March out!" cried the Emperor, for he was very angry; and both Princess and swineherd were thrust outside the city.

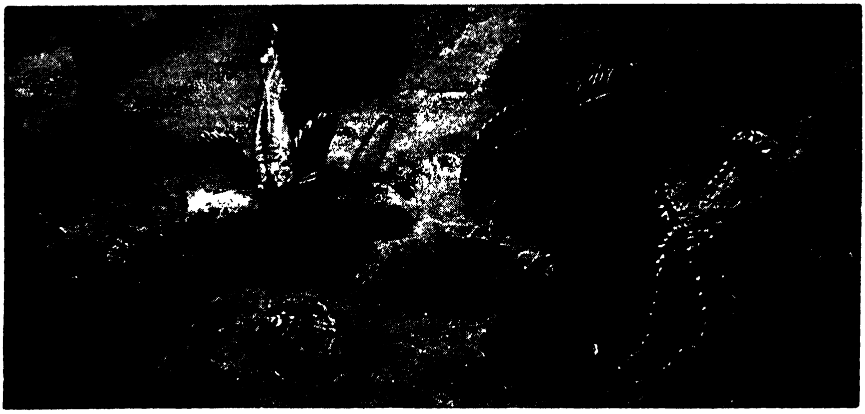
"Alas!" cried the Princess. "If I had but married the handsome young Prince! Ah, how unfortunate I am!"

Then the swineherd went behind a tree on the river bank, where he had hidden his own garments. There he washed the color from his face, threw off his dirty clothes, and when he stepped forth in his princely robes he looked so noble that the Princess could not help but bow before him.

"You are rightly served!" he said. "You would not marry an honorable Prince; you could not prize the rose and the nightingale; but you were ready to kiss the swineherd for the sake of a trumpery plaything!"

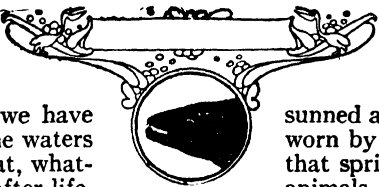
And the poor Prince, turning away, went back to his kingdom alone.

THE NEXT STORIES ARE ON PAGE 5685.



At the bottom of the sea.

LIFE IN THE WATERS



WE have traveled far together in pursuit of knowledge of mammal, bird or reptile. Now we have come to the brink of the waters to survey the things that, whatever their way in after-life, must obey the summons of Nature to lay their eggs in moist places.

We have explored mountain and valley, jungle and marsh; now we embark on the deeps, the water. We have considered every known class of land animals, yet have described the residents of only two-sevenths of the area of the world. Five-sevenths of the world remain, all under water. There is life in every drop of this vast world of sea and ocean, river and lake.

The oceans are constantly evaporating and pouring their rivers of vapor into the air. They descend as rain, snow and hail, to fill lakes and rivers, which carry back to the seas many millions of cubic miles of water every year. The streaming oceans give the dew of life to the land, quench our thirst, sustain plant and animal, and support within their depths the greatest of all assemblages of known life.

In no place are more astounding wonders found than in the waters. It is a realm where surpassing beauty contrasts with grim hideousness, a place of idyllic existence in sunny seas by golden sands and fairy caves, balanced by dark deeds perpetrated in unsunned abysses; of lovely colors worn by fish and shell, of light that springs from the bodies of animals, of fishes with eyes like gleaming lamps, of other fishes that are blind.

Nowhere do we find contrasts more startling. Here a single drop of water is the entire world of many animalcules. One of them would be desolate, lost at sea, if left alone in a globule of moisture—so unthinkably tiny is it. In such a speck of water there may be more living creatures than there are people in this whole country.

The tiniest things that have life are in the waters, and so are the greatest. At the one extreme are these microscopic perfections, uncountable in their profusion. At the opposite extreme is the whale, a hundred feet long and weighing two hundred tons. We must stand at a height to realize the immensity of a whale; we must peer through the microscope to grasp the small proportions of the others.

But how important is the tiny thing! We talk of Emerson's little poem about the mountain and the squirrel, and the retort of the merry little fellow that if he could not carry mountains on his back, neither could the mountain crack a nut; and we say to ourselves that the animalcules can make mountains as well as perky squirrels crack their nuts. Yes, limestone, chalk, marble and many other rocks were all alive once. Diatoms, radiolaria, foraminifera grow patterned shells of silica or carbonate of lime. They live and die in billions, and their little shells, welded by time and tide, have been raised so high during the centuries that mountain ranges have been formed from their remains.

If Time could run backward, we might see such marble statues as the Venus of Milo, the Laocoön, Michelangelo's David, and the lost works of Phidias dissolve into life and rearrange themselves into myriads of living specks from the water within shells exquisitely carved by the chisel of Nature.

All kinds of life are in the waters. There are tiny specks of living jelly, mere pulsing mites of living matter. They reach maturity in less than an hour, then divide in halves, so that one becomes two, two become four, four become eight, and so on, until at the end of twenty-four hours, one may have multiplied into a million.

THE ASTONISHING WAY IN WHICH A LIFE GOES ON AND ON

That is an example always cited as a sort of immortality, the same life extending and ranging on in this amazing way, age after age. Of course, death comes every hour to billions of these amebas, as they are called, or in a few weeks all the waters would be solid with them. Everything is food for something else, from diatom to dolphin, and each type has some part to play. Such things as diatoms are believed to have an important business in creating oxygen for the waters, as do the water weeds which we put for the same purpose into an aquarium.

These lesser forms, the diatoms, the animalcules, with swarms and swarms of eggs and minute fish and crustaceans, make up the diet of larger forms. In turn the larger forms are food for herrings, mackerel, salmon and—whales.

The sea has its rhythms, not yet explained. We know that sunlight brings a great increase of the lowlier types, so that they color the waters for hundreds of miles. For instance, they give the Red Sea its name, from the color they bestow on it in their seasons of abundance. And as this food supply rises, so the food supply of the greater fish is enriched. If fish hatch out when the supply is absent, they die. So sunshine promotes health and harvests not only ashore but in the ocean.

MYRIADS OF SMALL CREATURES MAKE THE SEA LIKE MOLTEN SILVER

Great variety and beauty of pattern mark the shells of the animalcules, but that is not the chief wonder. Some of them glow at night with phosphorescent light. We have luminous glow-worms, fireflies, centipedes and other brilliant insects on land, but we have nothing like the *noctilucæ* of the sea. They abound in such myriads that sometimes at night, as a ship's prow cuts the waters, the sea seems to catch fire and the ship seems to move on molten silver. The unthinkable swarms of these little animals, thickly clustered in every inch of sea, have kindled their glowing torches, that is all.

They are not the only ones which have this gift. Down in the gloom, weird fishes, with stomachs like great nets that inclose victims actually larger than themselves, and with teeth like rakes of bone, have also this wondrous light. They light their head-lamps in the dark. Whether they do this to see other fishes or to lure other fishes to their terrible jaws we know not. But they do it, and there is an octopus in tropical waters which has a glow-lamp like an electric torch. By it we can see the fantastic horrors of this monster, clawed like a tiger.

We have glanced at the importance of the diatoms in adding oxygen to the sea. Water creatures, though generally they breathe in a way different from mammals, must have oxygen.

NATURE'S CLEVER DEVICE FOR HELPING THE FISHES IN THE WATER

Man can obtain oxygen from water, but only by an elaborate and costly process. Water creatures take it out of the water and pass it into their bodies as easily as we inhale it. The more active and ambitious the form, the more its demands for this vital principle of life. The presence of this swim-bladder is an index to the life the creature leads.

The flat fishes lying on the oozy bed of the sea have no such organ, but fishes which make great journeys at high speed usually carry this aid to efficiency. This swim-bladder possibly serves a double purpose. In part it may be Nature's way of regulating the depth of its possessor in the sea. In part it is a reservoir for the source of energy.

The air-bladder, as it is commonly named, does not contain ordinary air, but mainly oxygen mixed with slight traces of carbon and nitrogen. This reserve store of oxygen can be drawn on instantly if need arises for some great muscular effort, such as catching prey or escaping capture. Associated with this method of storage is another curious one, the dark coloration of the flesh.

The dark color of the salmon, mackerel and tunny is simply stored energy made visible. These fishes are tremendously powerful swimmers, speedy, far-voyaging, enduring. The color we see in their flesh is hemoglobin stored in the muscle, ready to be changed into energy at need.

But it will be objected that not all fish keep to the water, and that is so. There are certain fish which have lungs as well as gills. The mudfish, for example, coils itself up in a ball within a clod of mud and sleeps away the season when its native river is dry. In that clod it can be carried unharmed round the world.

THE FISH THAT PACKS UP MOISTURE AND GOES ON LAND

Some catfish can store up air in a wonderful way; the climbing perches, which leave. their ponds and climb trees, have a complex form of gills in which they can seal enough oxygen-giving moisture to furnish them for their land travels. And there are fishes of the goby tribe which can skip about the mud with their whole bodies exposed to the air, except the tail, which must remain immersed or moistened to permit its owner to continue alive.

It is an interesting question how color came into the life of the waters, and what its purpose is. The average fish is perfect in grace and outline, in silvery mail, in grace of movement. We cannot understand why sea gardens should be lovely with vegetation, why coral islands and reefs should be like little dream cities of exquisite hue, set beneath the sea. We cannot imagine the purpose of the colors with which the cowry is lavishly endowed. There is not one more exquisite on any canvas by an Old Master than those which adorn the soft repulsive body of these sluggish creatures in shells; yet the gift is, so far as we can see, entirely wasted in the dark waters, hidden by the animal's own structure.

THE RAINBOW FISH THAT LURES ITS ENEMY TO DESTRUCTION

Superb colors adorn many of the fish, and here we do get a clue to purpose. Those most highly colored are generally unfit for human food. In some cases we find that the dazzling beauty is a decoy fish, which, when pursued, darts into the interior of a massive sea-anemone, followed by its foe. The little rainbow fish is unharmed in that gloomy fleshy cavern, but the fish which pursues it is paralyzed and digested by its host. The handsome lure remains inside while digestion takes place, but afterward escapes.

That is an outstanding example of co-operation, and the waters teem with them. The hungry shark has its guide, or companion, in the little pilot fish which precedes or follows it, as the hyena precedes or follows the lion. The hermit crab, housing itself in a discarded shell, enjoys a partnership with a sea-anemone, which it carries about with it, at once a mask and a bait. The oyster is sought by a parasite, and covers the parasite with nacre, the marvelous fluid which hardens into the pearl.

Of the modest European river mussel there is a still stranger tale to tell. The pearl is a tomb: the mussel is a nursery. A little fish called the bitterling seeks out the open shell of the mussel and drops eggs there. In the folds of the mussel's mantle the eggs hatch into fishes. The shellfish carries the load for a month or more, when the intruding infants escape into the water.

HOW THE MUSSEL AND THE BITTERLING IMPOSE ON EACH OTHER

But the mussel puts her little ones out to nurse with the bitterling. These cling to the tiny fish. As they grow they cause an irritation on the skin of the fish, so that abnormal growth is promoted and the skin grows over the mussel. So housed, the baby mussel goes riding to and fro, part of the body of its host. At the proper time it leaves its living home and drops into the water. There it settles down with millions of other mussels, spins a cable of silk, and anchors itself securely to stones or piles. Engineers sometimes throw thousands of mussels on the masonry of a breakwater, knowing that the mussels will bind the blocks more securely than cement.

We have animals which, falling short of true flight, have reached the parachute stage. So in the midst of the sea we have fish, not unlike slim greyhound herrings, which, with the water as a springboard, leap into the air and fly 150 feet at a time. Their fins are greatly lengthened for the purpose, so they must have been air-skimming for ages. These flights of the flying fishes are probably often the outcome of sheer delight and play. But danger must have been the primary impulse out of which these extraordinary excursions in the air were begun by the flying fish. Life in the waters is one unending round of danger. Nearly all fishes are flesh-eaters, and therefore their life depends on their killing other creatures.

Now, as we have often had an opportunity of seeing, Nature takes notice of the perils to which her children are exposed. The greater the danger, the more Nature drives a species to seek to multiply. And nowhere do we see such enormous outputs of potential life as in the waters.

HOW NATURE ADJUSTS THE BALANCE OF LIFE IN THE WATERS

In some cases it would seem as if no number of eggs, however great, sufficed to overcome the prospect of extinction. In such conditions Nature has decreed that the mother fish shall not lay her eggs broadcast, but shall retain them in her body so that they may safely hatch there. Sharks are born alive, powerful young cruisers from the instant of birth; and some of the rays, certain surf-haunting perches, do the same. There are other fishes that incubate their own eggs.

The rule on land is that animals which produce their young alive, or incubate their eggs, are responsible for only a small number. The totals in the water are enormous, even for those in which the eggs are not put forth. A blenny may give birth to more than two hundred young ones at a time. The great shark, with fewer foes to fear and all the sea animals to feed on, produces but a few young at a time.

In the majority of cases fishes lay eggs, and for the most part trust to chance to bring them to maturity. Of course they do not all reach the desired goal; if they did, navigation by man would become impossible in a single summer. When salmon are running in great numbers up certain American rivers, instances are on record where steamers have been brought to a standstill by the press of fish, their propellers unable to move.

THE OYSTER THAT MAY LAY SIXTY MILLION EGGS IN A YEAR

That would be the case in every sea and every river if the life spread on them every year were not as a banquet for the consumption of all comers. For a mother salmon lays a thousand eggs for every pound of her weight, and she may weigh fifty pounds. The eel will lay perhaps ten million eggs. The European ling is a veritable miracle in the number of its eggs; over 28 millions have been found in the body of a ling weighing 54 pounds. A turbot has been known to have nine million eggs, a cod quite as many. The hard roe in a herring may contain 50,000 eggs. The oyster, which becomes an adult in three years, is said to be capable of laying 60 million eggs a year.

Now, all that Nature demands from a single pair of parents, no matter to what order they belong, is that they shall, at the end of their lives, leave two of their kind to take their places. It is because of the risk of this not happening, of a species being slowly driven to extinction, that this enormous fruitfulness is necessary. If the method changed; if it became safe for all sorts of fish to produce only one or two young, or as few eggs as birds do, life as a whole in the waters would vanish. The eggs and larvæ of all sorts of marine creatures are the natural food of other species of fish; the eggs and tiny baby fish and crustacea for the smaller tribes, the smaller tribes themselves for the greater fish and other animals, right on through the whole scale until we find the island-like sperm whale living almost entirely on enormous sea squids.

THE IMPULSE AND GUIDING FORCE OF THE CREATURES IN THE DEEPS

There is room for all species and for unthinkable populations of all species. It is numbers, not intellect, which count here. Instinct is the impulse and the guiding force of the creatures whose way is in the midst of the waters. The realm of the deeps abounds in fascination, wonder, charm and horror, but the qualities which made the mammals supreme are not there.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5629.

FAMOUS BOOKS

JOHN BUNYAN'S GREATEST WORK

No book, except the Bible itself, has had greater influence for good on the minds of men than The Pilgrim's Progress. Written in simple, straightforward English, by a poor tinker who became a powerful preacher of God's message to mankind, this immortal story is likely to be read as long as our literature endures. The story is told as an allegory, illustrating the trials that beset a Christian on his way through life. But it is better than most allegories, because the characters are so human. We are instantly interested in each for his own sake, as well as anxious to know what happened to them all. John Bunyan, the author, was born at Elstow, near Bedford, in 1628, and died in London in 1688. He was imprisoned for twelve years for daring to preach the Gospel without the sanction of the Church. While in Bedford prison he wrote the first part of his immortal story, which is here retold largely in his own words.

THE PILGRIM'S PROGRESS

As I walked through the wilderness of this world I lighted on a certain place where was a Den, and I laid me down in that place to sleep, and as I slept I dreamed a dream.

I dreamed, and behold I saw a man clothed in rags, standing in a certain place, with his face from his own house, a book in his hand, and a great burden upon his back. I looked, and saw him open the book and read therein; and as he read he wept and trembled, and at length brake out with a lamentable cry: "What shall I do?"

In this plight he went home and told his wife that he was informed that their city would be burnt with fire from heaven, in which fearful overthrow he and his wife, and his sweet babes would miserably come to ruin, except some way of escape could be found. His relations tried, without avail, to rid him of his fears.

Now, I saw upon a time when Christian—for this was the man's name—was walking in the fields that he was reading in his book; and as he read he burst out as before, crying: "What shall I do to be saved?" I looked then and saw a man named Evangelist coming to him, who asked: "Wherefore dost thou cry?"

When he had answered, Evangelist said: "If this be thy condition, why standest thou still?"

"Because I know not whither to go," he answered.

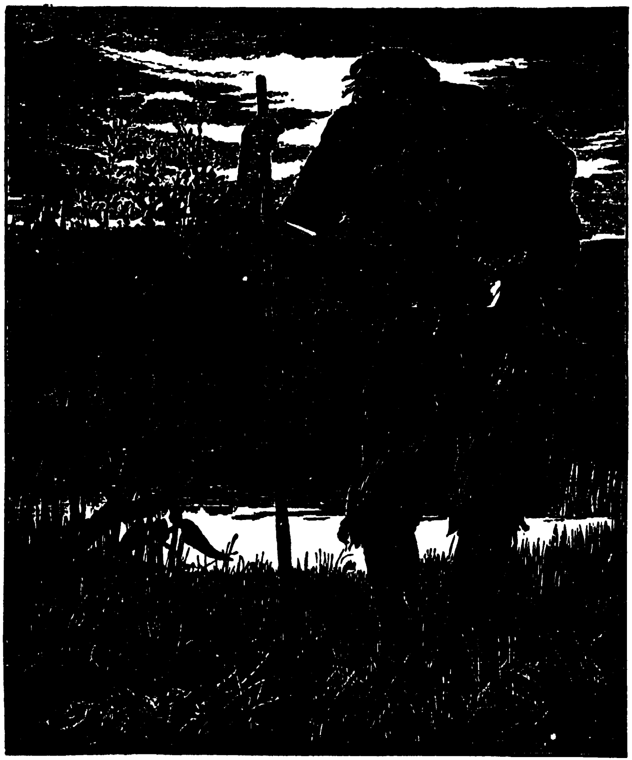
Then Evangelist gave him a parchment roll, and there was written thereon: "Flee from the wrath to come." The man read it, and, looking upon Evangelist carefully, said: "Whither must I fly?"

Then said Evangelist, pointing with his finger over a very wide field: "Do you see yonder wicket-gate?" The man said: "No." Then said the other: "Do you see yonder shining light?" He said: "I think I do." Then said Evangelist: "Keep that light in your eye and go up directly thereto, so shalt thou see the gate, at which, when thou knockest, it shall be told thee what thou shalt do."

So I saw in my dream that the man began to run. Now, he had not run far from his own door, but his wife and children and neighbors, perceiving it, cried out to him to return. But the man ran towards the middle of the plain.

Two of his neighbors, Obstinate and Pliable, resolved to fetch him back by force. When they came up with him, he told them that if they died in the City of Destruction, where he and they were born, they would sink lower than the grave.

They talked together, and Christian asked them to read in his book.



"I saw a man clothed with rags, a book in his hand, and a burden on his back. As he read he wept and trembled, saying, 'What shall I do?'"

Obstinate cried: "Away with your book! Will you go back with us or no?"

"No, not I," said Christian, "because I have laid my hand to the plough."

Obstinate then went back, but Pliable offered to go with Christian, and even urged him to mend his pace, when he heard further what the things were and how to be enjoyed whither they were going. But Christian had a burden on his back, and Pliable was unencumbered.

Now, I saw in my dream that, just as they had ended this talk, they drew very near to a very miry slough, and, being heedless, they did both fall suddenly into the bog. The name of the slough was Despond. And Christian, because of the burden that was on his back, began to sink in the mire. Then said Pliable: "Ah, neighbor Christian, where are you now?"

"Truly," said Christian, "I do not know."

At this Pliable began to be offended, and angrily said to his fellow: "Is this the happiness of which you have told me all this while? May I get out again with my life, you shall possess your brave country alone for me." And with that he gave a desperate struggle and got out of the mire on that side of the slough which was next to his own house, and Christian saw him no more.

Christian, left to tumble in the Slough of Despond alone, endeavored to struggle to that side that was next to the wicket-gate; which he did, but could not get out, because of the burden that was upon his back. But I beheld in my dream that a man came to him whose name was Hope, and set him upon sound ground.

Now, as Christian was walking along by himself, he was met by Mr. Worldly Wiseman, who advised him that he could get rid of his burden much more easily by applying to one Legality, whose

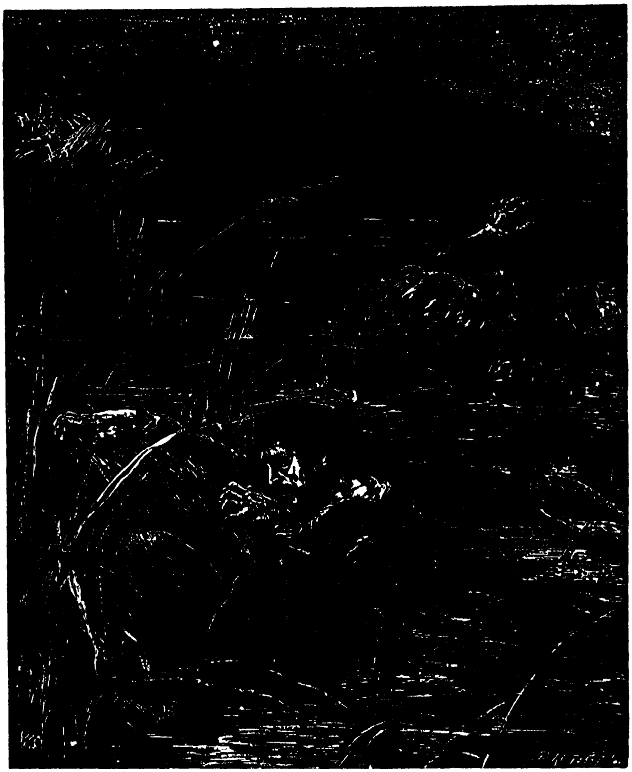
Pliable, who became afraid, and deserted Christian.

house was on a high hill which he pointed out. So Christian turned out of his way to go to Mr. Legality's house for help, but when he got hard by the hill it seemed so high, and that side of it which was next the wayside did hang so much over, that Christian was afraid to venture further. His burden seemed heavier, and flashes of fire came out of the hill that made Christian afraid that he should be burnt.

In this way he was found by Evangelist, and once more set on the right path; and so in process of time he got up to the wicket-gate. The gate was opened to him by Goodwill, who, after hearing his story, asked him to look before him at a narrow way.

"That," said Goodwill, "is the way thou must go."

"But," said Christian, "are there no turnings or windings, by which a stranger may lose his way?" "Yes," said the other, "there are many ways butt down on this, and they are crooked and wide. But thus thou mayest know the right from the wrong, the right only being straight and narrow."



Early in the journey they fell into the Slough of Despond. Pliable got out on the side nearest home, but Christian struggled to the other side.

Obstinate, who tried to bring Christian back.

Then Christian went on till he came to the house of the Interpreter. After he had knocked, as he had been told to do by Goodwill, and the door had been opened, I saw in my dream that the Interpreter took him by the hand, and, leading him within, showed him a picture of the man whom the Lord of the place whither he was going had authorized to be his guide, and other excellent things such as would be a help to him in his journey. When the Interpreter had given him his blessing, Christian went on his way, pondering on the things that had been shown to him.

Now, I saw that the highway up which he had to go was fenced on either side with a wall, called Salvation. Up this way, therefore, did burdened Christian

Christian had much profitable discourse in the Palace Beautiful.

run, but not without great difficulty, because of the load on his back. He ran till he came at a place somewhat ascending, and upon that place stood a cross, and a little below, in the bottom, a sepulchre.

So I saw in my dream, just as Christian came up with the cross, his burden loosed from off his shoulders, and fell from off his back, and began to tumble, and so continued to do till it came to the mouth of the sepulchre, when it fell in, and I saw it no more.

Then was Christian glad and lightsome, and stood a while to look and wonder, till the springs that were in his head sent the water down his cheeks. As he stood looking and weeping for gladness, behold three Shining Ones came to him and saluted him with: "Peace be to thee." The first said to him: "Thy sins be forgiven thee"; the second stripped him of his rags, and clothed him with change of raiment; the third also set a mark on his forehead, and gave him a roll with a seal upon it, bidding him look on it as he ran, and that he should give it in at the Celestial Gate. So they went their way, and Christian gave three leaps for joy and went on singing.

CHRISTIAN'S FIGHT WITH APOLLYON

WHILE resting on the hill called Difficulty, Christian fell into a deep sleep. And as he slept his roll dropped from his hand. At the summit of the hill he met two men, named Timorous and Mistrust. They said they were returning, because the farther they went the more dangers they met with.

This caused Christian to feel in his bosom for his roll, that he might read therein and be comforted. But, finding it not, he went down the hill again to the arbor, where he had slept. Who can tell how joyful this man was when he had gotten his roll again, which was to be his pass into the Celestial City? How nimbly did he now go up the hill! But before he got up, the sun went down upon him, and he thought of the lions in the way, of which Timorous and Mistrust had told him. But while he was blaming himself for sleeping, he lifted up his eyes and saw before him a stately palace, the name of which was Beautiful. So he made haste that, if possible, he might get lodging there.

Before he had gone far he entered a very narrow passage, about a furlong off the porter's lodge, and espied two lions in the way. The lions were chained, but he saw not the chains, and was afraid. But the porter, whose name was Watchful, called out to him to keep in the midst of the path, if his faith was strong enough. This Christian did, and so entered the Palace Beautiful, which was built for the relief and security of pilgrims.

There came forth to meet him a beautiful damsel called Discretion, who, on learning his story, called out Piety, Prudence and Charity. Thus was Christian welcomed into the house.

Here he had much profitable discourse, such as he had had at the Interpreter's house. After supper, Christian was given a large upper chamber, whose window opened toward the sun-rising, and here he slept till the break of day.

Before he left this place, the rarities of which were shown to him, he was taken up on to the roof, whence he beheld at a great distance a most pleasant mountainous country. The mountains were the Delectable Mountains, and the country was Emmanuel's Land, from which he was told he could see the gate of the Celestial City.

Christian was now anxious to be setting forward, but before letting him go his hosts took him into the armory, where they harnessed him from head to foot, except upon his back, with what was proof against attack, lest perhaps he should meet with assaults on the way. At the gate he learnt from the porter that one Faithful, a fellow-townsman, had passed that way.

TIMOROUS

MISTRUST

On the Hill Difficulty, Christian met Timorous and Mistrust, who were coming back because the dangers that lay ahead made them lose heart.

Then he began to go forward, but Discretion, Piety, Charity and Prudence accompanied him to the foot of the hill, which led to the Valley of Humiliation. Christian went down very warily, for the hill was dangerous, yet he had a slip or two. When all were at the foot of the hill, his good companions gave Christian a loaf of bread, a bottle of wine, and a cluster of raisins; and then he went on his way. But poor Christian had gone only a little way in the valley before he espied a foul fiend, hideous to behold, coming to meet him.

The name of the fiend was Apollyon. Christian was at first afraid, and began to cast in his mind whether to go back or stand his ground. But as he had no armor on his back, he thought that to turn might give the enemy the greater advantage to pierce him with his darts. So he went on, and Apollyon, when he refused to go back, straddled quite over the way, and hurled a flaming dart at Christian's breast. Thus began a sore combat that lasted for over half a day.

When Christian had been wounded in head, hand and foot, and was almost spent, Apollyon came to close quarters, and, wrestling with him, gave him a dreadful fall, so that his sword flew out of his hand. Then said Apollyon: "I am sure of thee now." And with that he almost pressed him to death. But while Apollyon was fetching of his last blow, Christian nimbly stretched out his hand and, regaining his sword, gave the fiend such a thrust that he spread his dragon's wings, and sped him away. Then there came to Christian a hand with some of the leaves of the Tree of Life, which Christian took, and applied to the wounds which he had received, and was healed immediately. He also sat down in that place to eat bread, and to drink of the bottle that was given him a little before; so being refreshed, he addressed himself to his journey. Apollyon did not appear again.

Christian carried his drawn sword in his hand this time, fearing some other enemy, but he met with no other affront in this valley.

THE PILGRIMS IN VANITY FAIR

NOW, at the end of the Valley of Humiliation was another, called the Valley of the Shadow of Death. And Christian must needs go through it, because the way to the Celestial City lay through the midst of it. The pathway was extremely narrow. On the right hand was a very deep ditch. On the left hand was a very dangerous quag. Besides, the darkness was so great that Christian could hardly tell where, or on what, in going forward he should next set his foot.

About the midst of this valley, and near the wayside, was the mouth of the Underworld. Ever and anon flame and smoke would come forth with hideous noises. Christian heard doleful voices, and fiends came towards him. Near the burning pit one of the fiends came up softly to him, and whisperingly suggested many bad thoughts to him, which he verily believed had proceeded from his own mind.

When Christian had traveled in this disconsolate condition some considerable time, he thought he heard the voice of a man, as going before him, saying: "Though I walk through the Valley of the Shadow of Death, I will fear no evil, for Thou art with me." Then he was glad, because he gathered that some who feared God were in this valley as well as himself. Then the day broke, and Christian said: "He hath turned the shadow of death into the morning."

This was another mercy to Christian, for, from the place where he now stood to the end of the valley, the way was all along set full of snares, nets, and pitfalls. In this light, therefore, he came to the end of the valley.

Now, as Christian went on his way he came to a little ascent, which was cast up on purpose that pilgrims might see before them. Up there Christian, looking forward, saw before him Faithful, his fellow-townsman, of whom he had heard from the porter at the Palace Beautiful. Then said Christian aloud: "Ho, ho, soho! stay, and I will be thy companion!"

Then I saw in my dream that they went very lovingly on together, and had sweet discourse of all the things that had befallen them in their pilgrimage, and of what had happened in the City of Destruction after Christian had left.

When they were got out of the wilderness, they presently saw a town before them, and the name of that town is Vanity. And at the town there is a fair kept, called Vanity Fair; it is kept all the year long. Almost five thousand years ago there were pilgrims walking to the Celestial City, and Beelzebub, Apollyon and Legion, with their companions in evil, perceiving that the pilgrims' way to that city lay through this town of Vanity, contrived here to set up a fair, wherein should be sold all sorts of vanity, and that it should last all the year long.

Now, as I said, the way to the Celestial City lies just through this town, where this lusty fair is kept; and he that will go to this city, and yet not go through this town, must needs "go out of the world." The Prince of princes himself, when here, went through this town to his own country, and that upon a fair-day too. Yea, and as I think, it was Beelzebub, the chief lord of this fair, that invited him to buy of his vanities; yea, would have made him lord of the fair, would he but have done him reverence as he went through the town. Yea, because he was such a person of honor, Beelzebub had him from street to street, and showed him all the kingdoms of the world in a little time, that he might (if possible) allure that Blessed One, to cheapen and buy some of his vanities. But he had no mind to the merchandise, and therefore left the town, without laying out so much as one farthing upon these vanities. This fair therefore is an ancient thing, of long standing, and a very great fair.

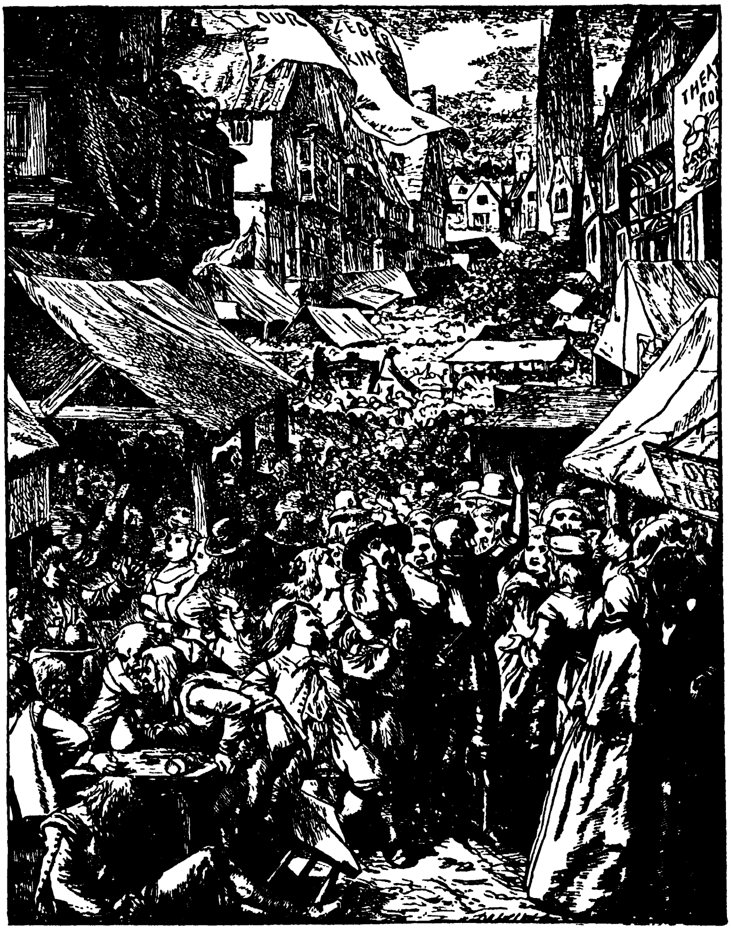
As Christian and Faithful entered into Vanity Fair, the people wondered at their apparel and at their speech. The town itself was in a hubbub about them. That which did not a little amuse the merchandisers was that these pilgrims set very light by all their wares. They cared not so much as to look upon them, and when asked what they would buy answered gravely: "We buy the truth."

The behavior of Christian and Faithful so little suited the people of Vanity Fair that the pilgrims were taken and examined, and those that examined them did not believe them to be any other than mad, or else such as came to put all things into a confusion in the fair.

Therefore they took them and beat them, and besmeared them with dirt, and then put them into a cage, that they might be a spectacle to all.

Then some of the men in the fair, that were more observing than the rest, seeing the patience of Christian and Faithful, began to check and blame the baser sort for their treatment of the pilgrims. Thus, after words had passed on both sides, the disputants fell to blows.

Then were these two poor men brought before their examiners again, charged with causing the hubbub, beaten, loaded with irons, led in chains up and down the fair as an example and terror to others, and with threats remanded again to the cage and their feet were put in the stocks.



Christian, who is here dressed in his armor, and his new companion, Faithful, came to Vanity Fair, a resort of all sorts of wicked people, which is on the way to the Celestial City and must be passed through by every traveler. The two pilgrims were very shamefully treated at Vanity Fair, Faithful being put to death.

A convenient time being appointed, they were next brought before Lord Hate-good for trial. They were charged with injuring the trade of the town, and with causing commotions by winning a party to their most dangerous opinions. Evidence against Faithful was given by Mr. Envy, Mr. Superstition and Mr. Pickthank, and, the jury finding him guilty, he was sentenced to the most cruel death that could be invented. They therefore brought him out, scourged him, buffeted him, stoned him, pricked him with their swords, and finally burned him to ashes at the stake. But a chariot and horses waited for him, and took him up through the clouds to the Celestial Gate.

As for Christian, he was taken back to prison, where he remained for a space, but He that over-rules all things so wrought it about that Christian escaped them and went his way.

And as he went he sang, saying,

"Well, Faithful, thou hast faithfully profest
Unto thy Lord, of whom thou shalt be blest,
When faithless ones, with all their vain delight,
Are crying out under their hellish plight:
Sing, Faithful, sing, and let thy name survive,
For though they kill'd thee thou art yet alive."

When the believer has done his work, the wrath of man may be permitted to expedite his removal to his heavenly inheritance, beyond which all the malice and power of earth and hell are utterly unavailing against him.

The jury that tried Christian and Faithful for disturbing the peace of Vanity Fair with their strange doctrines was composed of Mr. Blind-man, Mr. No-good, Mr. Malice, Mr. Love-lust, Mr. Live-loose, Mr. Heady, Mr. High-mind, Mr. Enmity, Mr. Liar, Mr. Cruelty, Mr. Hate-light, and Mr. Implacable. These characters the artist tries to show in the faces of the jury; for faces often indicate character.

CAPTIVES IN DOUBTING CASTLE

NOW, I saw in my dream that Christian went not forth from Vanity Fair alone, for there was one whose name was Hopeful—being made so by the beholding of Christian and Faithful in their words and behavior in their sufferings at the Fair—who joined himself unto him, and, entering into a brotherly covenant, told him that he would be his companion.

Having passed over the little plain called Ease, and refused the invitation of one Demas that they should leave the narrow way to look at the silver-mine on the hill called Lucre, they came to a stile leading into Bypath Meadow.

The road that they had come by was very rough, and Christian, looking over the stile, saw that a path led along by the way on the other side of the fence.

"Here is the easiest going," said Christian. "Come, good Hopeful!"

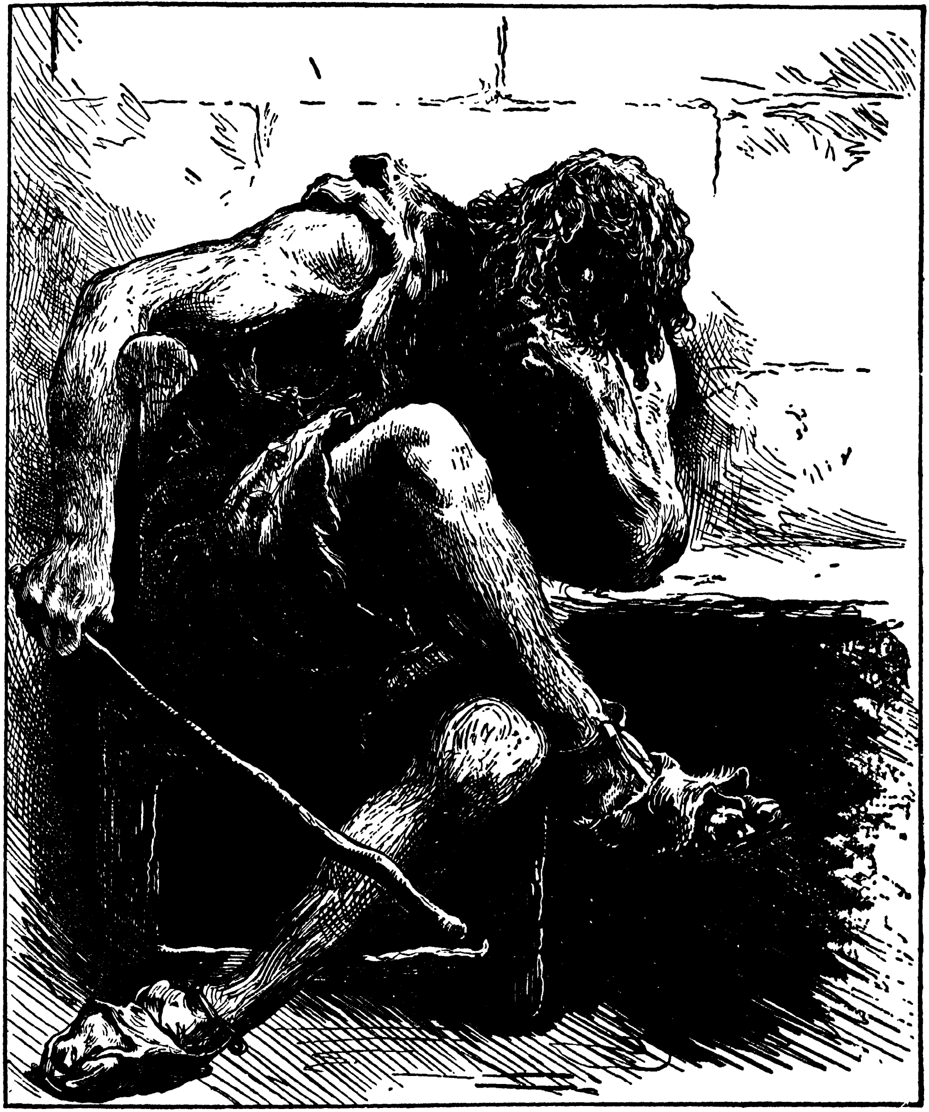
"But how if this path should lead us out of the way?" said Hopeful.

Christian remarking that it went along by the wayside, Hopeful was persuaded, and the two went over the stile, and found the path very easy for their feet. Presently the night came on, and it grew very dark; then it began to rain and thunder and lighten in a very dreadful manner. They saw they had lost their way, and Christian began to blame himself for bringing his companion out of the way.

But Hopeful comforted him and forgave him, and presently they were at rivalry as to who should go first, and so meet any danger that might lie in wait for them on the way back to the stile. By this time the waters were greatly risen, and the way was perilous. At last, lighting under a little shelter, after having been nearly drowned nine or ten times, they decided to rest there till daybreak. But, being weary, they fell asleep.

Now, near where they lay was a castle called Doubting Castle, the owner

GIANT DESPAIR IN DOUBTING CASTLE



Giant Despair, who lives in Doubting Castle and tries to make life unendurable to all doubters so that they may destroy themselves, failing which, he kills them himself. Christian and Hopeful were happily able to escape from Giant Despair, as Christian had the key of Promise, which opens Doubting Castle.

whereof was Giant Despair; and it was in his grounds that they were sleeping. And he, getting up early, saw them, bade them awake, and, driving them before him, put them into a dark and stinking dungeon of his castle, where they lay from Wednesday morning till Saturday night.

On the Thursday, acting on the counsel of his wife Diffidence, Giant Despair got a crab-tree cudgel, wherewith he beat them fearfully. On the next morning, again on the advice of his wife, he came to them and advised them to make away with themselves. And when they prayed him to let them go, he rushed upon them, and had doubtless made an end of them himself, but that he fell into one of his fits—for he sometimes, in sunshiny weather, fell into fits—and lost for a time the use of his hands.

Towards evening the Giant went down into the dungeon again, and, finding that they were still alive, fell into a rage and threatened them so dreadfully that Christian's courage began to fail. But Hopeful comforted him by reminding him of the victory he had had over Apollyon, and how he had come through the Valley of the Shadow of Death.

On Saturday morning, the Giant, having had further counsel with his wife, had the prisoners into the castle yard, and, after showing them the bones and skulls of those he had already despatched, told them he would tear them into pieces within ten days. With that he beat them all the way back to the dungeon.

That night the Giant and his wife began to renew their talk about their prisoners; and the Giant wondered that he could neither by his blows nor his counsel bring them to an end. His wife replied that she feared they lived in hope that someone would come and release them, or that they had picklocks about them. The Giant at this resolved to search them in the morning. But about midnight on the Saturday, Christian and Hopeful began to pray, and a little before day Christian exclaimed:

"What a fool am I thus to lie in a stinking dungeon, when I might as well walk at liberty! I have a key in my bosom, called Promise, that will, I am persuaded, open any lock in Doubting Castle."

And he pulled it out. It opened the dungeon door, the outward door, and the iron gate.

The gate as it opened made such a creaking that it waked Giant Despair, who, hastily rising to pursue his prisoners, felt his limbs fail; for his fits took him again, so that he could by no means go after them. Then they went on, and came to the King's highway, and so were safe, because they were out of the Giant's jurisdiction. But at the stile they put a notice warning other pilgrims.

THE END OF THE PILGRIMS' JOURNEY

CHRISTIAN and Hopeful afterwards came to the Delectable Mountains. Here they were welcomed by the shepherds. The shepherds, whose names were Knowledge, Experience, Watchful and Sincere, had them to their tents and gave them good counsel as to their way, and showed them through their perspective glass the gates of the Celestial City.

So they went on, and behold a man, black of flesh but covered with a very light robe, came to them, and, learning that they were bound to the Celestial City, bade them follow him, for it was thither, he said, that he was going.

Now, the name of this man was Flatterer, and by-and-by, before they were aware, he led them both within the compass of a net. Then in their distress they remembered the shepherds had warned them of the man.

At last they espied a Shining One coming towards them, with a whip of small cord in his hand. When the Shining One was told that they were poor pilgrims going to Zion, he rent the net, put them in the way again, and, having chastised them, bade them go on and remember the other warnings of the shepherds.

They went on till they came into a certain country, whose air tended to make one drowsy if he came a stranger into it. Hopeful was for falling asleep, but Christian remembered that this must be the Enchanted Ground, of which they had been warned. And so, to prevent themselves from falling into a sleep from which there was no awakening, they fell to good discourse.

In time they were got over the Enchanted Ground, and entered into the country of Beulah, whose air was very sweet and pleasant. The way lying directly through this country, they solaced themselves there for a season. Here they heard continually the singing of birds, and saw every day the flowers appear in the earth, and heard the voice of the turtledove in the land. In this country the sun shineth night and day; wherefore this was beyond the Valley of the Shadow of Death, and also out of the reach of Giant Despair, neither from this place could they so much as see Doubting Castle. Here they were within sight of the city they were going to, also here met them some of the inhabitants thereof. And drawing near to the city they had yet a more perfect view thereof.

It was builded of pearls and precious stones, also the street thereof was paved with gold; so that by reason of the natural glory of the city, and the reflection of the sunbeams upon it, Christian with desire fell sick. Hopeful also had a fit or two of the same disease.

But being a little strengthened, they went on, and as they went they were met by two men in raiment that shone like gold, also their faces shone as the light. These men asked the pilgrims whence they came; and they told them. Then said the men: "You have but two difficulties more to meet with, and then you are in the city." Christian, then, and his companion asked the men to go along with them; and they said they would. So they went on together until they came within sight of the gate. But betwixt them and the gate was a river, and there was no bridge to go over. The river was very deep.

Christian and Hopeful crossing the river to the Celestial City. When their faith was strong in the King of the Celestial City, so would they find the river shallow, and when their faith was weak, the river would be deep.

The men that were with them, in answer to their questions, told them that they must go through the river, which they would find deeper or shallower as they believed in the King of the place. They then entered the water, and Christian began to sink, crying out to his good friend Hopeful: "I sink in deep waters; the billows go over my head."

Then Hopeful bade him be of good cheer, and had much ado to keep his brother's head above water. But after a while they both took courage, and Christian presently found ground to stand upon, and so it followed that the rest of the river was but shallow. Thus, they got over.

Now, upon the bank of the river, on the other side, they saw the two Shining Ones again, who there waited for them. Wherefore, being come out of the river, they saluted them, saying: "We are ministering spirits, sent forth to minister for those that shall be heirs of salvation." Thus they went along towards the gate.

Now, you must note that the city stood upon a mighty hill, but the pilgrims went up that hill with ease, because they had these two men to help them up by the arms. They had likewise left their mortal garments behind them in the river.

And I saw in my dream that Christian and Hopeful, after giving in their certificates, went in at the gate; and lo, as they entered, they were transfigured, and they had raiment put on that shone like gold. There were also those that met them with harps and crowns, and gave these to them. Then I heard in my dream that all the bells in the city rang again for joy, and that it was said to them: "Enter ye into the joy of your Lord."

So I awoke, and behold it was a dream.

. . . .

But Bunyan dreamed another dream, and in this dream he saw how Christian's wife and children set forth from the City of Destruction, and, reaching the Interpreter's house, were put in charge of one Great-heart, who guided them to the Celestial City, whither Christian had gone before them. The story of this forms the second part of his great work. In this is told how Giant Despair was slain by Great-heart, and how Doubting Castle was destroyed in seven days.

It is in this that the shepherd boy is heard singing the now famous lines:

He that is down, needs fear no fall,
  He that is low, no pride;
He that is humble, ever shall
  Have God to be his guide.
I am content with what I have,
  Little be it, or much;
And, Lord, contentment still I crave,
  Because thou savest such.
Fullness to such a burden is
  That go on pilgrimage;
Here little, and hereafter bliss,
  Is best from age to age.

THE NEXT STORY OF FAMOUS BOOKS IS ON PAGE 6110.

Netherlands Information Bureau, New York

The broad, flat plains of the Netherlands are covered by a network of canals and spotted with picturesque windmills.

The STORY *of the* NETHERLANDS

THE highest and lowest lands in Europe are linked together by the river Rhine. Far away amid the mountains of Switzerland it starts on its long journey, leaping like a merry child, till it passes into the quiet waters of Lake Constance. Thence emerging, with growing strength it dashes and roars as it tumbles over the rocks at Schaffhausen, and flows, in staid middle life, rapidly and steadily north, useful and strong and beautiful, for many, many miles through Germany. After passing the grand gate of the Seven Mountains near Cologne it goes more slowly, as if age had come upon it, and at last, stretching out weary arms, it seems to be blindly searching for the sea, in which to end its winding course in peace.

The triangle of low land on the shores of the North Sea between France and Germany lies in the grasp of these arms of the Rhine, and about the lower courses of the Meuse and the Scheldt where the great north plain of Europe is narrowest. It has been known through history as the Low Countries, or as the Netherlands, the word nether meaning "lower."

Small as the region is, it has fallen into two distinct countries, occasionally united under one rule. Holland, the hollow or marshy land, the northern and larger half, lies chiefly in the Rhine delta. Belgium, to the south, has but fifty miles of coast, and consists of the lowlands drained by the Meuse and Scheldt, and the highlands of the Ardennes.

If we are visiting Holland we can land either at Flushing, on an island on the north bank of the Scheldt, or at the Hook of Holland, on the north side of the Meuse, which leads to Rotterdam, the great port of Holland. The channel of the Meuse is the chief entrance to the Rhine.

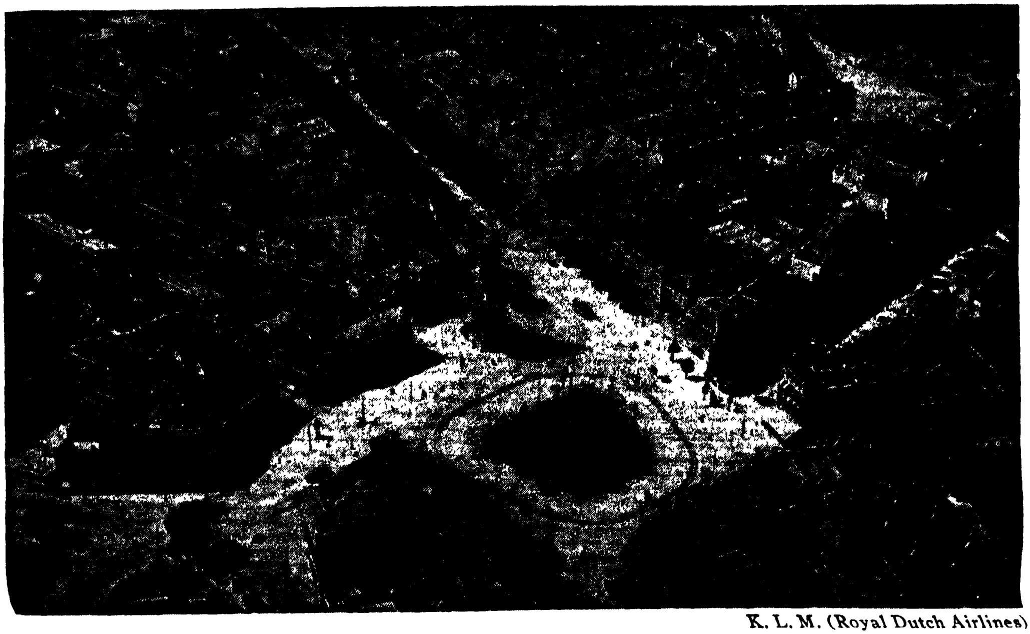
Between Flushing and the Hook are the numerous fertile islands formed by the sediment brought down by the great rivers, so here we have some of the earth of Switzerland, Germany and France. North of Rotterdam are The Hague, the seat of Holland's government and royal residence; Utrecht, Leyden and Haarlem, so famous in history; and Amsterdam, Holland's official capital and largest city of commerce, on the one-time Zuider Zee. The Zuider Zee was the youngest sea in the world, for it was formed only about six hundred years ago, when the water burst in over the land, sweeping away villages and farms and people. One-fourth of Holland's area is below the level of the North Sea.

There is an old Dutch proverb that God made the sea, but man makes the shore. For more than a thousand years the making of that shore has been the first duty and thought of those who, living in Holland, wished to protect it, and enlarge its borders, against the storms and tides that dash against it. For years engineers have been engaged in turning most of the Zuider Zee into dry land. A great dam cutting it off from the North Sea was the first step.

Let us stand on one of the great dikes, as the Dutch call their sea walls. It is perhaps sixty feet high, and broad enough at the top for a motor road, bordered with trees and buildings. The sea laps quietly, though it may rage and roar tomorrow, not far below the level of this road. Boats come alongside to little piers and quays. The other side slopes deep down to the green meadows, so that we on the dike can see down the chimneys of the houses nestling below, and the fish on the one side are higher than the birds in the trees on the other. Very strong, built of stones and cement and willow boughs, are these walls which push back the ocean. Constant care is needed to see that there is no leak and that the gates and sluices are in perfect order.

There are strong walls, too, around the lakes and on the banks of the rivers that become flooded when the snow melts in the distant Alps; and everywhere are canals and ditches, cut to regulate the flow and to help the land to keep its head above water. In many places continuous pumping has to be carried on, and this is done in part by the windmills that are such a feature of the country. From the top of the dike we can perhaps count twenty or more, though many are now being replaced with water pumps driven by motors.

Besides pumping and draining, the windmills saw up wood and grind corn. Much fertile land is formed by draining the marshes, which has been done with enormous toil and skill. As we pass from The Hague to Haarlem in the train we see one of the largest polders, as the drained marshes are



K. L. M. (Royal Dutch Airlines)

An airview of the East Square section of Rotterdam, *Holland, before its destruction by German bombs in 1940.* In the center of the picture is the famous Old Mill, which had become a landmark for tourists.

Netherlands Information Bureau, New York
Canals make many Netherlands cities a "northern Venice."

called, beautiful green and highly fertile.

If our visit is in the early summer, the reclaimed land will be brilliant with the lovely bulb flowers for which Holland is so famous. In most of the towns canals run through the streets. Amsterdam, for instance, is built on almost as many islands as Venice, and the canals are crossed by three hundred bridges. The soil is so moist that houses have generally to be built on a foundation made firm by driving in piles. Erasmus, the great scholar who lived in Rotterdam, and did so much to prepare the way for the Reformation, had this in his mind when he said that he knew a city in which people lived like crows on the tops of trees.

Most of Holland is so flat that a single warning signal for cyclists can serve a large area. If we mount the towers of any of the fine old churches we can see all around for miles, right away to the distant horizon. And a bright and wonderful view it is on a sunny day—quite dazzling, for the water shines everywhere, and so do the brass weather-cocks and the steel railway lines; even the sails of the boats on the canals gleam against the green of the fields. It is strange to see sails mixed up with trees, especially when the rivers or canals are higher than the fields. And over all is the tenderest and most delicate light, which Dutch artists know so well how to paint in their pictures.

IN WINTER, HOLLAND IS COVERED WITH A MANTLE OF WHITE

In the winter a very different scene meets the eye. Instead of the vivid green, a mantle of white rests over all, and the gleaming waters of the canals and ditches are frozen hard and are covered with skaters—doctors going to their patients, children to school, workers to their offices and factories. The Dutch are among the best skaters in the world.

Let us leave the busy and populous Belgium of today and the Holland so carefully wrested and guarded from the ocean, and glance at their story. For nearly two thousand years the Netherlands sought to keep their small corner of Europe independent, and so strengthened and educated themselves that for centuries they have been among the world's teachers in many of the matters worth knowing. Let us survey the history of these countries, and see how they developed into great modern nations.

The Low Countries are but a dull, damp district, shut in by the gloomy depths of boundless forests, when we first catch sight of them in the early days of Rome. For countless ages the rivers, which are numerous all over the land, had been steadily bringing down slime and mud, and the wind and tide had been occasionally dispersing and destroying the banks thus formed.

The early Celts may have chosen these shifting swamps for their home and lived among the tangled brushwood on the islands at the mouth of the Rhine.

THE BRAVEST OF THE EARLY SETTLERS WERE THE BELGAE

The bravest of them were the Belgae, who have left their name in Belgium. By the time the Romans came, several German tribes had occupied the land. Among them the Batavians and the Frisians were celebrated for bravery and love of freedom, and for their determination to protect the land on which they dwelt. The Batavians proved of great use in the Roman armies.

In the fourth century A.D. the Frankish tribes came swarming over the Rhine. By degrees they absorbed the Frisians and the Batavians and the rest of the tribes living in the morasses and low plains, till, in the eighth century, all the country fell under the rule of the Frankish emperor Charlemagne. He left the people their native customs, and put chiefs over them whom they had to obey.

Part of Charlemagne's plan was to give wealth and power to the bishops of the newly converted tribes, and for nearly a thousand years these prince-bishops were very important. After Charlemagne's death the empire broke up, and under the weak rulers that followed, the independent nobles became ever stronger.

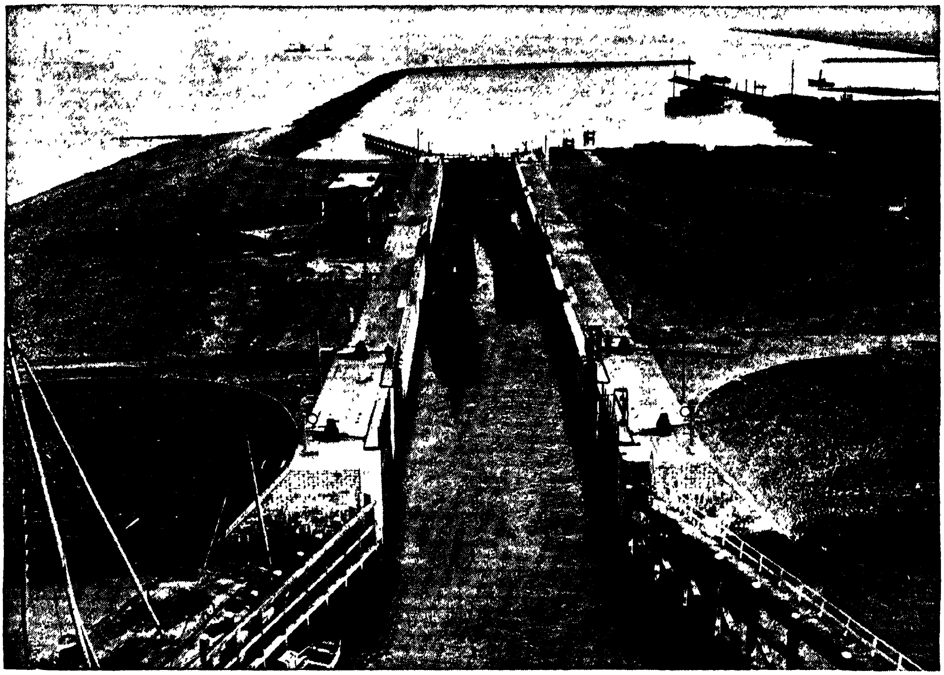
An old law of one of the small states (Friesland) declares that "the race shall be free as long as the wind blows out of the clouds and the world stands." This principle has always been kept in view, even in times of overwhelming trouble.

Feudalism developed as a system of defense when the Northmen began their raids. The invaders never made any permanent settlements here. Being far from the courts of emperor and king, the local lords finally acquired great power.

We know how the rise of important towns has always helped on the cause of freedom, and though the towns in the Netherlands are not quite so old as some in France, Italy and Germany, most of them date from early times. When trade was set moving by the influence of the Crusades, the towns of the great north-and-south route began to rise from small beginnings to wealth and power. From the thirteenth to the fifteenth century the towns of the Netherlands did much business with the towns of the famous Hanseatic League of traders. In the fourteenth century there were over three thousand woolen factories around Malines, now the center of the Belgian railway lines; Ghent had 40,000 weavers; and the goldsmiths of Bruges were numerous enough to form a regiment by themselves in time of war. The towns of Delft, Haarlem, Rotterdam and Amsterdam were all growing, though often laid waste by the quarrels of landowners and townsmen.

It was at this time that England grew so much wool for Flemish looms. Linen, too, of various kinds was added to the manufactures. Holland, a stout material used for overalls, is still known by the name of the country where it has always been woven on a large and extensive scale.

But all the time when trade and industry were growing, amid constant scenes of violence and fighting in the streets of the flourishing towns, the struggle against the elements was forever going on. When the fierce winds heaped up the sand in hills on the shore, the Netherlanders planted coarse grass to bind the sand hills together to make a rampart. When the river overflowed, the



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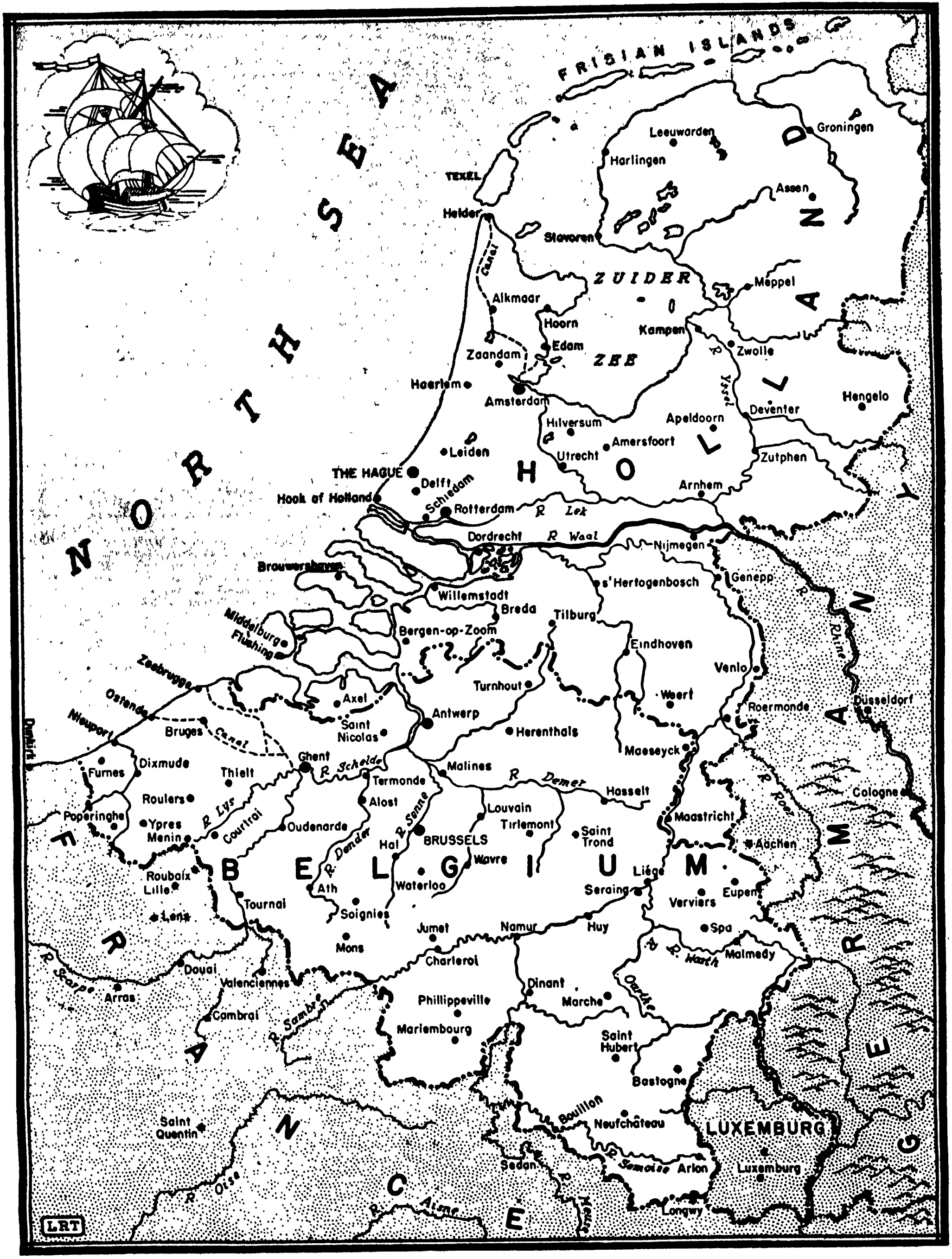
So much of Holland is below sea level that the country must be protected from flood with a clever system of locks.

THE LOWLANDS: HOLLAND AND BELGIUM



Bounded by France to the south, Germany to the west, and the North Sea to the north and east lies the little triangle of land known through history as the Netherlands, or Low Countries. Much of this country is below sea level and the waters of the North Sea must be pushed back by an elaborate system of locks and dikes. Holland, in the north, is mostly low marsh-land cut by canals draining into the Rhine river and then into the sea. Belgium, in the south, is drained by the Meuse and Scheldt rivers, which run northward to the sea.

banks were strengthened and heightened; and so by degrees, by patient trial and endeavor, that wonderful skill was attained in making canals and draining lakes, and in building dikes that would withstand even the inward rush of the strong tide. Sometimes, as we have seen, the giant ocean had its way. It was in the thirteenth century that it rushed inland and formed the Zuider Zee. For years past many men have been laboring to drain this great body of water and restore the land to cultivation.

HOLLAND (The Netherlands)

Area: 12,800 square miles.

Population: 9,000,000 people.

Communications: Canals and rivers, 4,800 miles. Railroads, 2,300 miles. Regular airplane service.

Agricultural Products: Rye, oats, wheat, potatoes, sugar-beets, vegetables, fruits and bulbous plants. The village of Biskoop is the largest flower center in the world. Large milk output.

Manufactures: Machinery, especially electrical equipment, textiles (including rayon), diamond-cutting, distilling, sugar-refining, beet-sugar and cheese factories, salt works, breweries, tobacco factories. Shipbuilding is important. Delft is famous for pottery.

Minerals: Coal is the only important mineral.

Chief Towns: Amsterdam, capital, 790,000; Rotterdam, 600,000; The Hague (seat of the Court), 500,000; Utrecht, 160,000; Haarlem, 140,000.

Possessions: Located in the East Indies and the West Indies. Total area, 790,000 square miles; population of 72,000,000. **Netherlands Indies:** Java and Madura, Sumatra, Borneo, Celebes and New Guinea (western half is Dutch, eastern half is British and Australian). Capital is Batavia, Java. **Netherlands West Indies:** Surinam (Netherlands Guiana), Curaçao, Aruba, Bonaire.

All this effort for generations produced a wise and determined race. Though few in numbers, and living in a small country, yet they were able to resist in the fifteenth and sixteenth centuries the fierce tyranny of the most powerful of the sovereigns of Europe. To understand this resistance we must review certain historical events.

For a dark cloud began to grow over the Netherlands when, by seizure, purchase, succession, and marriage of heiresses, the most considerable of its states passed under the sway of the dukes of Burgundy. These dukes wished to annex Switzerland as well as the Netherlands and make one long independent kingdom between France and Germany. The crafty Louis XI of France was firmly against this, and was at constant warfare with Duke Charles the Bold of Burgundy. From the daughter of Charles, Mary, was wrested the Great Charter. This led to the first regular assembly of the states-general, the members of which were sent from the provinces and great cities of the Netherlands.

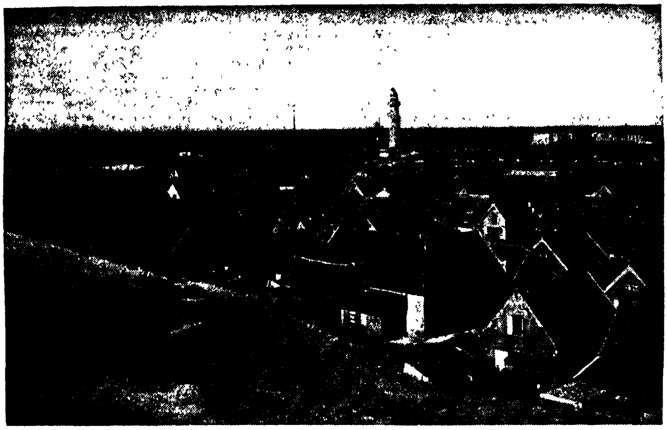
The young Duchess Mary married Maximilian of the Hapsburg family; and their son Philip succeeded to his mother's dominions and married the daughter of Ferdinand and Isabella of Spain. Philip's son was the famous Charles V, who gathered into his hand the rule of the Netherlands as well as that of Spain and Austria. All these countries hated each other, and the liberties of the Netherlands were in terrible danger from a prince who firmly believed that he had the sole right of disposing of the persons and lives of his subjects, as well as settling their faith and religion.

Charles, in spite of his wide empire, was always in need of money, and he expected the rich cities of the Netherlands, especially Ghent, to furnish it whenever he chose to ask for it. When denied, he took away all the charters and rights of those who opposed him, and fined and executed the citizens. Hard as this was, especially when trade from different causes did not bring in so much wealth as formerly, it was not to be compared with the suffering inflicted on the country through Charles' tyranny in matters of religion. This came about at the time of the Reformation.

We know how the teaching of Luther raised a storm in Germany and in England. Calvin, another reformer, powerfully affected France and the Netherlands. In these countries the rulers opposed the Protestants, not only because their beliefs were contrary to established doctrine, but also because some denied the absolute power of the rulers themselves. So, as the Netherlanders became more and more convinced that the Reformation was right, and bent all the strength of their determined natures to uphold it, the more bitter became the persecution of those in power, in order to stamp it out. Charles established the terrible Inquisition in the Netherlands, and some of the reformers were burned under his orders.

His son, Philip II, carried out his father's plan only too well. When the unhappy people prepared to rise in revolt against his cruelties, he sent the Duke of Alva, a clever soldier and a man absolutely without pity, to suppress them. Almost the entire population of the Netherlands was sentenced to death without even the form of a trial, and people were seized and killed without warning, till there was hardly a family that did not suffer bereavement.

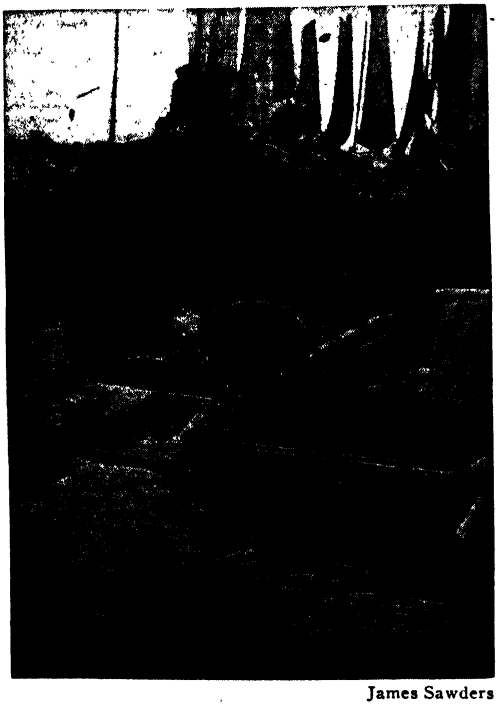
A national hero rose up at this time in William the Silent, Prince of Orange. William was brought up under the eyes of Charles V. When the old and tired Emperor finally laid down all his crowns to go into a monastery, it was on William's arm that he entered the great hall at Brussels, where the ceremony of renunciation took place.



Netherlands Information Bureau, New York

A lovely little seaside village of northern Holland with a friendly lighthouse in the background and the North sea stretching in the horizon.

William very soon ceased to be friends with Philip II, though for years he was called his lieutenant. After William openly became a Protestant, he was leader of the opposition to the bloodthirsty Alva. The patriots called themselves, at first in grim jest, the Beggars. Sometimes they won, especially at sea; sometimes the Spaniards had the best of it; and the struggle went on for many years.



James Sawders

Fresh herring is a favorite food in Holland and always available. The fish are kept alive in crates submerged under the sea water until they have been carried to the market and are ready to be sold.

Stories of the heroism shown in this war of independence are told of every town of the Low Countries. The sieges of Haarlem and of Leyden are among the most memorable. Leyden held out a whole year, except for a brief respite, and the heroic defenders were reduced to starvation, but would not give in. There were fights on the slippery ice in the bitter winter. As a last resort the dikes were cut, and the water flowed over the fields, forcing the Spaniards away in haste lest they should be drowned, and allowing ships to come right up to the walls of the town, with their precious food for the starving inhabitants.

After a while the provinces of Holland and Zealand united. When they felt strong enough, they took the important step of renouncing the authority of Philip. England helped them cautiously, and one of the bravest of the English volunteers who pressed across the North Sea to help the Netherlanders was Sir Philip Sidney, whose story is told elsewhere in THE BOOK OF KNOWLEDGE.

After several unsuccessful attempts at union and at making peace with Spain, Dutch independence was declared in 1581. William the Silent, affectionately called "Father William," was the head of the new republic. It was nearly seventy years before

Spain gave up all her claims and titles and acknowledged the complete independence of the Dutch people.

The victory was followed, as has so often been the case in history, by a tragic act. Three years after the declaration of independence the wisest man in Holland was murdered by a Burgundian hired by Spain. As long as William the Silent lived he was the guiding star of a brave nation, and when he died, the little children cried in the streets.

No man in the history of the world has deserved more truly to be called great than this silent Dutchman. He was not naturally grave and thoughtful. He was inclined to live happily for the enjoyment of the moment. He was rich and fond of luxury. He was a Catholic in religion, and a friend of the great Catholic kings of Spain and France at a time when the clash of religious beliefs was most fierce. If he had been content to see injustice and cruelty flourish, it would have been quite easy for him to stand aside and let religious strife take its own disastrous way apart from him.

But William was honest enough in feeling, and bold enough in thought, to see that the torture and murder of people of other beliefs is utterly wrong, whether done in sheer tyranny or in the name of religion. His manhood revolted from the hideous persecutions that were deliberately introduced into the Netherlands and were countenanced alike by Spain and France.

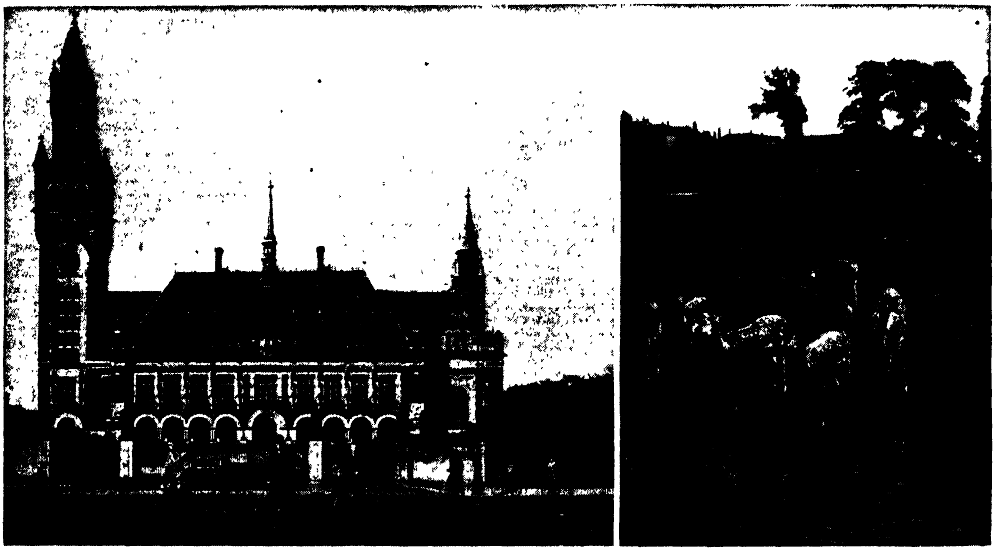
He gave up the natural brightness of his life, his wealth and ease, and he faced danger, slander, poverty and outlawry on behalf of what his heart told him was right. He changed from the religion of his youth. Whatever came, he must be faithful to the best within himself; and he remained triumphantly faithful even to death by the hand of a hired assassin. William the Silent, the great man of Holland, is the typical great man of all mankind—great in soul; and so he will ever remain a man for coming men to know. He was truly a giant among men.

War still went on under his son Maurice. The southern states, with their great towns of Antwerp and Ghent and many others, were reduced to obedience to Spain for many years after the northern states became free. Protestantism had been stamped out, the brave and clever Flemish workers had been driven away to Holland or to England, to the great and lasting benefit of these lands; and the subdued country lay in poverty and exhaustion. Ten years after the rout and ruin of the Armada, started by the fire ships and the storm off the coast of Flanders, Philip died, unregretted, after a reign of forty-two years. His determined efforts to reduce the Netherlands to subjection only hastened the day of their final liberation.

It was in 1600 that Queen Elizabeth formed the East India Company, hoping to secure for England some of the rich profits that trade with India had been bringing to Spain. Holland followed suit two years later. Much money was spent on fleets and ports and factories. From these days the sailors of Holland—trained in the wild fishing grounds of the North Sea—were to be found all over the world taking possession of the Spanish and Portuguese colonies, and often hotly contesting with the English. New Amsterdam, afterward New York, was founded on this side of the Atlantic, and

James Sawders

A continual delight to visitors are the quaint old streets of many Netherlands villages and cities, where the gabled roofs seem almost to lean over winding, narrow passageways. As in many European cities, bicycles are more common than automobiles.



Netherlands Information Bureau, New York; James Sawders

Left, the Peace Palace at The Hague in Holland. Right, the Deer Park in the center of the city.

many old New York families are proud of Dutch descent. The city of Batavia was founded in Java, called after the old island, the kernel of the mother country. To this day Batavia is the capital of the Dutch East Indies. Amsterdam and Rotterdam and all the old cities now revived, as trade flowed in with the arrival of ships laden with "sugar and spice, and all that's nice," at the busy quays.

As soon as peace gave leisure, pumping works were established to drain lakes and marshes, and the rich meadow land thus gained fed the finest cattle in Europe. Dutch butter and cheese have long been famous all over the world. Another use to which the land gained from the sea was put, was to grow roots for food and various bulbs of beautiful flowers, like tulips. The Dutch taught all Europe how to garden and farm. At this time, also, Holland became the printing house of Europe, sending out thousands of books on history and travel, law and medicine.

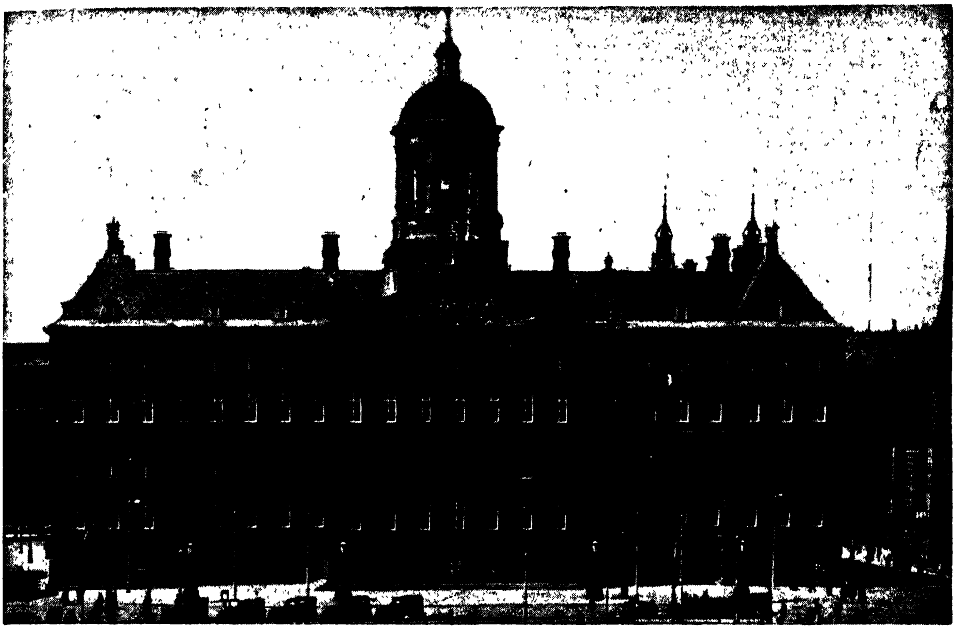
Trades, too, such as diamond-cutting—still carried on in Amsterdam—gave employment to large numbers of skilled workmen. It was in the seventeenth century that the rivalry between the Dutch and English on the high seas came to a crisis. There were many famous admirals, many brave seamen on both sides. Van Tromp and De Ruyter are Dutch names as well known as the English Blake and Monk. For years they tried to sweep each other off the narrow seas. London was in a panic when De Ruyter sailed up the Thames in the days of Charles II. Sometimes the obstinate sea battles lasted three or four days, for both sides belonged to a stock that never knows when it is beaten.

A SUDDEN THAW SAVES THE NETHERLANDS FROM FRENCH CONQUEST

In the age of Louis XIV, France made several conquests in the Netherlands, and to save the country the dikes were opened. Later the waters froze, and when the French troops were marching over the ice to attack The Hague a sudden thaw saved the country from destruction. The head of the republic at this time was the great-grandson of William the Silent. His name was also William, and he married the daughter of James II of England. When England wanted to get rid of the Stuarts, William was invited over to be king in James's place.

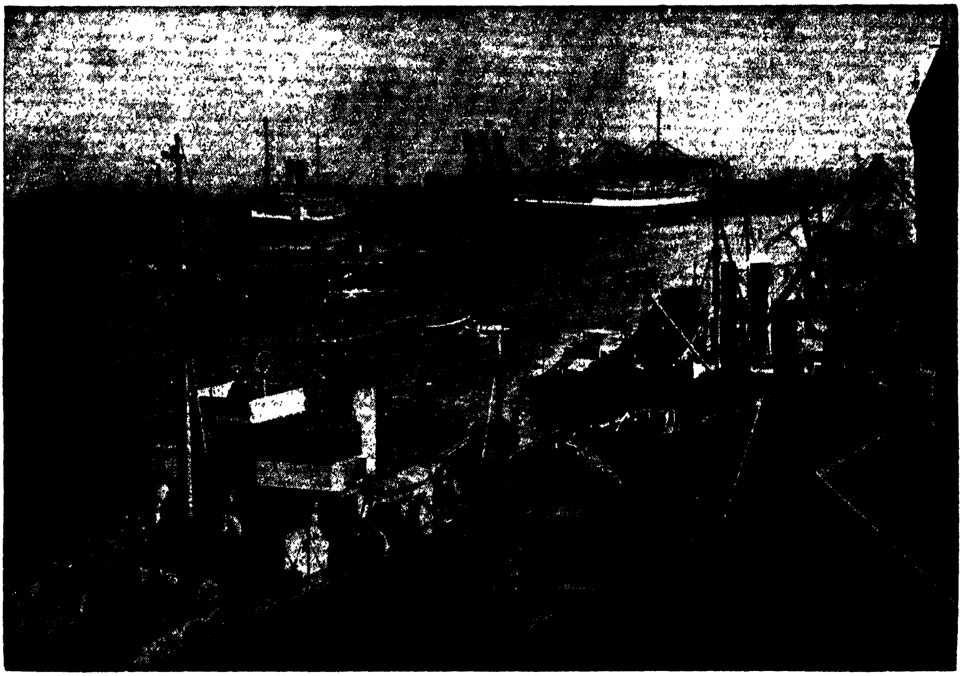
In the eighteenth century the importance of the united provinces of the Dutch Republic became less than it had been in the seventeenth. There were many disturbances in the country, which led to the interference of the King of Prussia. But the French Revolution was at hand, and before long the map of Europe was completely changed, and bewildering changes came to the Low Coun-

IN BUSY AMSTERDAM



James Sawders

A view of the Queen's Palace, formerly the Town Hall, in Amsterdam. This magnificent building dates from 1648 A.D.



Netherlands Information Bureau, New York

Huge, modern steamship liners, coastal steamers, freight barges, even little fishing boats crowd the busy harbor of Amsterdam. Amsterdam is one of the greatest centers of commerce and trade in Europe.

tries, both north and south. The seven united provinces were turned into the Batavian Republic, and a few years later Napoleon turned it into a kingdom for his brother Louis. But that did not last long. He soon took his brother away, and joined Holland and all the other provinces to France. "They are but the sediments of French rivers," said he, "and therefore clearly belong to me."

When the Congress at Vienna remade the map of Europe after Waterloo, the whole of the Netherlands was joined into one kingdom under another William, Prince of Orange. But the northern and southern provinces did not agree about religion, the south being chiefly Roman Catholic; and they differed on many other matters, too. In 1830 the south revolted. The old Spanish Netherlands became the kingdom of Belgium under a German prince, Leopold of Coburg, whose great-grandson, Leopold III, was king of the Belgians in 1940, when the Germans conquered the Low Countries.

But let us go back to the 1830 revolt. The northern provinces continued as the kingdom of the Netherlands, or Holland. The present sovereign is Queen Juliana, who succeeded her mother, Wilhelmina, in August of 1948. Wilhelmina abdicated (gave up the throne) after a reign of fifty years.

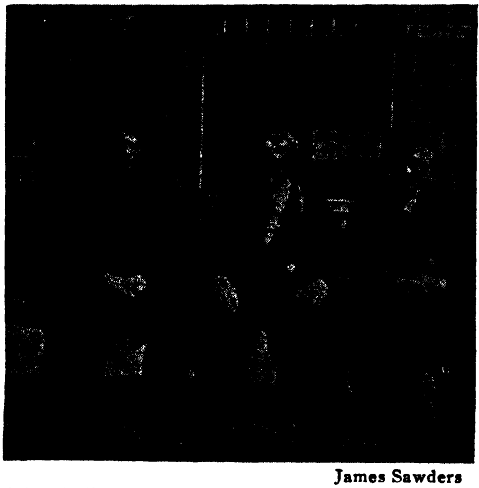
Between Amsterdam and the sea is the famous North Sea canal, which saves ships going round the peninsula of north Holland. It is about fifteen miles long. Both at Amsterdam and Rotterdam, in ordinary times, the trade is enormous.

Holland is one of the oddest and most amusing countries in the world. Though water is everywhere, there is sometimes not a drop fit to drink, and people have to buy it by the pailful, as they often buy some firing to boil their kettles. From the high dikes frogs can look down on the birds, and in the damp fields the cows wear coats. Water omnibuses ply for fares on the canals, and coal and peat are brought by brown-sailed boats, or motor craft, which are hitched up to the door.

For ceremonial occasions, the peasants wear beautiful gold ornaments and costly lace on their heads. Dogs draw little carts with brass jars full of milk. The brass and copper shine like gold, and everything that can be scrubbed is scrubbed at least once a week, including the railway stations.

James Sawders

Colorful Dutch costume.


James Sawders

A few Hollanders still wear their traditional costume: baggy woolen breeches, short coat and wooden shoes.

James Sawders

In some parts of Holland vegetable carts are still common. Here one is pulled by an obliging dog.

Netherlands Information Bureau, New York

Dairying is an important and profitable industry in Holland.

James Sawders

Dutch cheese, the best of Holland's dairy produce, is famous the world over.

When World War I broke out, in 1914, Holland and Belgium were in a perilous position. Both countries barred Germany from a stretch of seacoast which she wanted, and which would have increased enormously her opportunities of attack.

But Germany considered that Holland, as a neutral country, was a protection against a flank attack from the North Sea, and kept an open way to the sea in the British blockade. So Holland was left alone, and during the war sold much food to her neighbor.

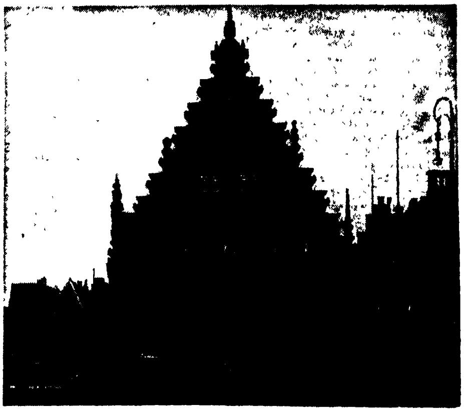
World War II was a different kind of struggle. Holland's coastline and ports were needed for stations where troops, fighting seacraft, aircraft and tanks, and supplies could be brought, in preparation for an invasion of Britain. Therefore, in the spring of 1940, Holland suffered a lightning attack from Germany, and in a few days was conquered, though she fought with bravery. Queen Wilhelmina fled to London, and Princess Juliana with her two little girls fled to Canada. The German occupation caused great misery and suffering. Liberation finally came in May, 1945, and Queen Wilhelmina and the Government returned to The Hague. Thus, Holland again gained her freedom.

Though Holland is small, it has been called "a great little nation." She became ruler of an empire nearly as far away as half around the world. The Dutch territories in the East Indies, with their much smaller holding in South America (Dutch Guiana and Curaçao), have a population of about 72,000,000. Thus little Holland, about seven times the size of Prince Edward Island, was one of the very considerable countries, ruling 81,000,000 people at home and abroad.

The only part of Holland that is hilly is the southern half of the inland province of

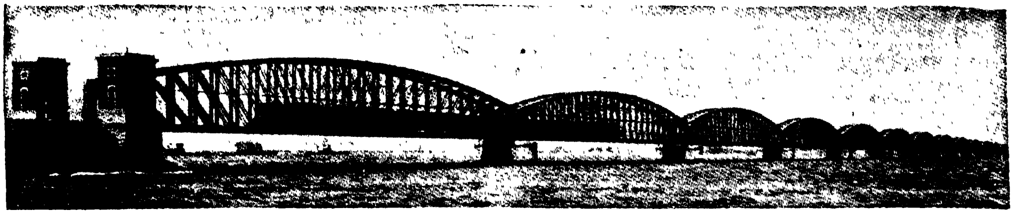
James Sawders

The cheese house in Alkmaar, the "cheese city."



James Sawders

Market Square, Haarlem, famous for its meats.



Netherlands Information Bureau, New York

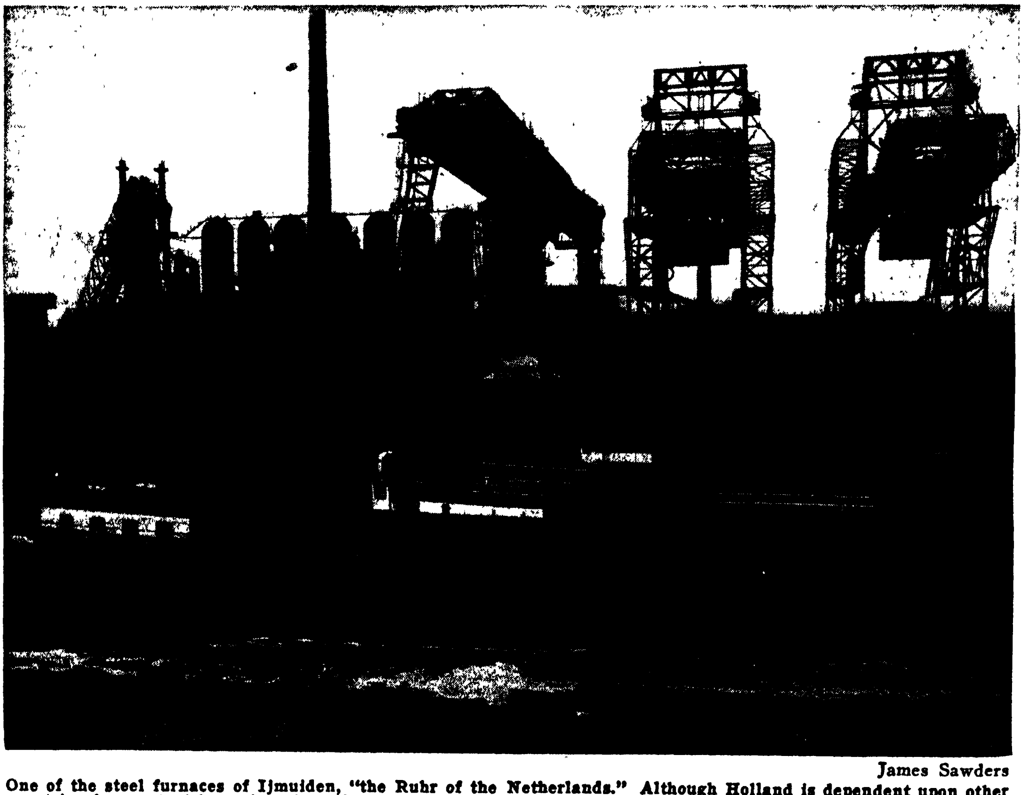
Parts of Holland are separated from the country proper by rivers, lakes and canals. Many fine bridges have been constructed to span the distance from one of these little island centers to another.

Limburg, which juts out between Belgium and Germany, and reaches a height of a thousand feet. In this district some coal is found; otherwise Holland depends on other countries for her mineral needs, apart from her territories, which produce some tin and good supplies of mineral oil.

The mainstay of Holland is in her agriculture, her fisheries, shipbuilding, carriage of goods, and the marketing of her territorial produce. Thirty-five per cent of the whole of Holland is laid down in pasture, and her dairy produce and manufacture of margarine are important. She is also a cattle-breeding country and has a good breed of horses. Some lines of her manufactures are connected with her territorial produce, such as cigars, tobacco, cocoa, chocolate and sugar, and she is a distributor of Eastern spices.

The chief products of her arable land are rye, potatoes, oats, beets and wheat. Holland has always claimed and taken a liberal share of the fisheries of the North Sea, especially its herring catch, and she has a considerable export of fish.

Her garden and vegetable trade took a



James Sawders

One of the steel furnaces of Ijmuiden, "the Ruhr of the Netherlands." Although Holland is dependent upon other countries for most of her mineral needs, she has enough coal for a minor iron-smelting industry.

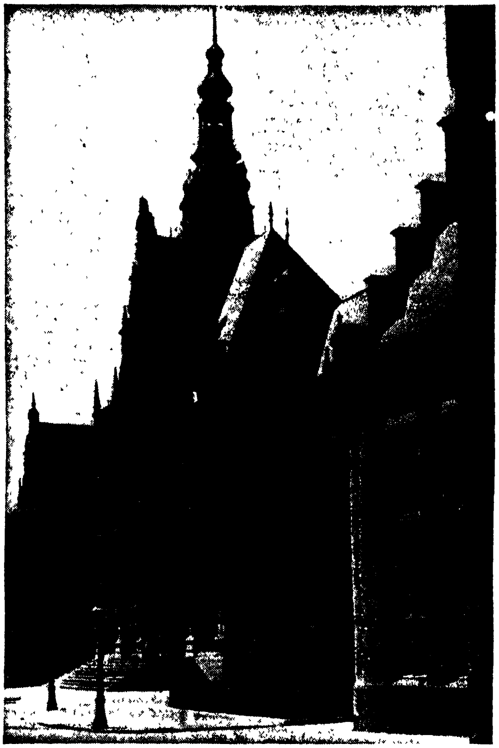
James Sawders

The historic Town Hall on Market Square, Delft, the center of the city's political life.

regular place in the English market with potatoes, cauliflowers, cabbages, onions, asparagus, and especially all kinds of bulbs—hyacinths, tulips, crocuses and narcissuses. The Dutch farmers and gardeners are careful, persistent and methodical. Poultry and bee-keeping are also important sources of profit.

This historical energy of the Dutch overseas shows itself in the prosperity of their two great cities—Amsterdam, with its 790,900 inhabitants, official capital and long a great center of commerce and finance; and the seaport of Rotterdam, which had over 600,000 people before the German *Blitzkrieg* of 1940 ruined the city. Other ports are Flushing and the Hook of Holland.

The Hague has a population of 500,000, and was the world's center for international law, very properly for three reasons. The Hollanders have a fine history as a freedom-loving people. The first great international jurist, Grotius, was a Hollander. And the country occupied a neutral position as a small country, yet important. The sensitiveness of some nations finds a cause for jealousy even in a simple matter like the choice of a place where international consultations may be held. This has led to the frequent choice of cities either in Holland or Switzerland for such meetings. There is an implied compliment in the fact that no nation can find ground for suspicion in these countries with their history of neutrality.



James Sawders

The Academy of Science in Groningen, North Holland.

Holland has, too, an honorable position in education. Her University of Leyden, in a town of 75,000 people, dates from 1575, and has been a center of liberal learning ever since. Amsterdam, too, has an old university, now municipalized, and the city was finely associated in the past with printing. Amsterdam still has a prominent printing trade. Other university towns are Utrecht, Groningen and Nijmegen. Some colleges have university standing.

Holland is largely a Protestant country, almost one-half of the people accepting the Protestant faith; but over one-third are Roman Catholics.

It is not generally remembered that, in the days when the Dutch were competing throughout the world with the Spaniards, Portuguese, English and French for distant trade and empire, it was they who, claiming the right to share in American colonization, founded what is now the second largest city in the world. New York, as we have seen, was originally a settlement of Dutchmen and was named New Amsterdam. South

Africa was largely colonized at first by the Dutch as a halfway connecting link with their East Indian possessions. Over large areas of the British Union of South Africa, people of Dutch descent form a majority of the white inhabitants.

The chief settlement of the Dutch in the Indian Archipelago was, and is, in the island of Java. Its capital, now a city of 533,000 people, was called Batavia, after the tribe of Batavians who originally lived in Holland between the two branches of the Rhine as it approaches the sea.

Java, about the same size as Alabama, is unsurpassed in the richness of its vegetation. It is thickly peopled by the yellowish brown Malay race, numbering 44,000,000, chiefly Mohammedan in religion. The second most important town is Surabaya.

All land in Java belongs to the Indonesians and can be leased, but not sold, to other nationals. It grows rice, sugar, cinchona (for quinine), coffee, tobacco, tea and indigo. Petroleum is one of the most valuable of the island's products, and rubber is very important. The great natural disadvantage of Java is a liability to earthquakes. Java was invaded by Japanese forces in 1942 and taken by them after fierce and stubborn fighting by both Dutchmen and natives, and not liberated until 1945.

Other Dutch territories in the East Indies are: Sumatra, more than six times the size of New Brunswick, with a population of about 8,000,000, exporting pepper, nutmegs and mace; Celebes, about half the size of California, with a population of 4,232,000; Dutch Borneo, with a population of 2,170,000; and Timor, with over 1,600,000 inhabitants. Dutch Guiana, or Surinam, in South America, is twice the size of Nova Scotia, has a population of 183,730, and exports bananas and coffee. The capital, Paramaribo, has 65,000 inhabitants.

Holland is an interesting example of the advantages a European country may derive from her colonies. There can be no doubt that her possessions in the East have stimulated her home industries and her commerical enterprise. She has carefully nursed her outlying possessions from the first, and used them to extend her trade; but her civilizing influence has also been felt by the native races she controls.

Many European peoples regard the Dutch, from outside their borders, as a quaint, industrious race, oddly dressed in the rural districts, prosperous in a quiet way, living in a dead flat land of doll-house architecture ornamented with windmills, or sailing the seas in broad-beamed ships. To a certain extent this is true. It is true also that the Dutch face the world with shrewdness, industry and energy. From a foundation, mostly of water-sodden soil, ungifted with earth's natural riches, they have built up an empire commanding the world's respect.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 5690.

Netherlands Information Bureau, New York

Lisse, Holland, the center of the bulb district. The cultivation of tulips, hyacinths, daffodils and other flower bulbs is one of the richest industries of the country. The tulip has become almost a national symbol.

SCIENCE

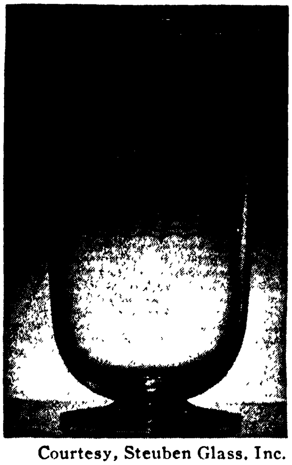
Courtesy, E. R. Squibb & Sons

CHEMISTRY IN TODAY'S WORLD

MANY hundreds of years ago, before anything was ever known about chemistry, man was feeding, clothing and sheltering himself as best he could with what nature provided at hand. Inquisitive, observant and always dissatisfied, he gradually learned to modify and change the materials provided by nature to suit his needs better. Out of countless years of experience, oftentimes aided by chance, the ancient arts of producing wines from fruit juices, of dyeing cloth, and of tanning animal skins developed and flourished. Still nothing was known of such chemical substances as alcohol (in wine) and tannic acid (in tanning). It has been only within the last few hundred years that the chemical nature of matter and chemical changes began to be understood. Then man began deliberately to make and change materials to make them longer lasting, more beautiful and more useful. Our knowledge and our use of chemistry have spread rapidly within this short time. It is often said that today is the Age of Chemistry. In other chapters of this department of Science we tell you about the basic principles of chemistry. Here we shall tell you of some of the ways in which chemists have put their knowledge to work, creating a gigantic industry.

Chemicals are the basic substances from which we produce fertilizers, many metals, plastics, resins, soap, glass, gasolines, medicinal compounds, insect-killers, synthetic fabrics and many other items. They are simple substances—acids, bases and salts for the most part—that we have already encountered in our study of chemistry. Nitric acid; sulfuric acid; quicklime, or calcium oxide; ammonia; and sodium carbonate, or soda ash, are important chemicals that must be made cheaply and in tremendous quantities. Let us glance at the story of nitric acid and ammonia.

Man depends upon the green plants for food for himself and his livestock. In turn, the green plants get food from the nitrates



Courtesy, Steuben Glass, Inc.

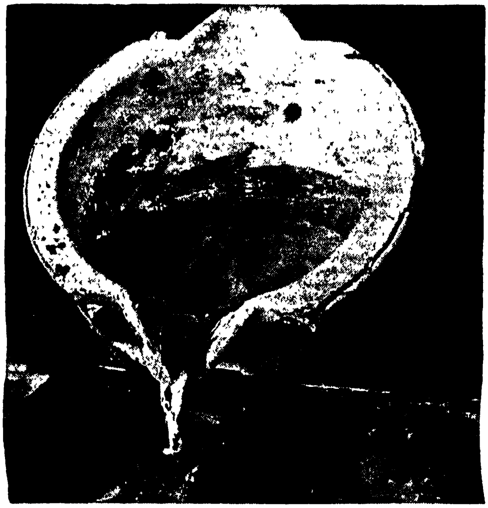
A delicately engraved vase, the product of certain chemicals and the skill of the glass maker.

in the soil. Continued replanting from year to year soon removes these nitrates, and the farmer finds it necessary to replace this loss by adding nitrate fertilizer. For many years our only supply of sodium nitrate was the vast deposits in the South American country of Chile. But sodium nitrate is also needed for other things. It is heated with sulfuric acid to produce the nitric acid required to make all high explosives; and man has had to use these high explosives all too frequently in modern warfare. Toluene, a harmless liquid hydrocarbon obtained from coal tar, is mixed with nitric and sulfuric acids to make the dangerous high explosive TNT. Cellulose, carbohydrate of which cotton is an almost pure form, is transformed by nitric acid into nitrocellulose. From this, strangely enough, both dynamite and rayon are made, and other things, too. The natural deposits of nitrates, therefore, could not supply for long the millions of tons of sodium nitrate used each year for fertilizers alone. But chemistry was not long in providing an abundant and cheap source—air and water! In the early 1900's two German chemists discovered that ammonia (NH_3) could be made cheaply by combining nitrogen from the air with hydrogen obtained form gaseous water, or steam. The ammonia obtained in this way could then be oxidized to nitric acid, which could be used as such or converted into nitrates for fertilizers. Today almost unlimited quantities of ammonia, nitric acid and nitrates are produced in this way.

Soap. The more civilized man becomes, the more soap he uses. Soap is formed when fats are boiled with an alkali. Sodium hydroxide (NaOH) is a common alkali. It is cheaply produced by passing an electric current through salt water. At first animal fats were used in making soap, but soon there was not enough to make all the soap and soap products that people needed. Man turned to chemistry for a new source of fats. He soon discovered that vegetable oils, especially cottonseed oil, could be hardened to a fat by passing hydrogen through them in the presence of a small quantity of a metallic element, nickel. These hardened vegetable oils are also used for shortening, replacing lard. Soaps are frequently made more attractive by coloring them with suitable pigments (coloring agents). They are also often scented with perfume, either natural or synthetic. For many purposes medicinal compounds are added to soap.

Whenever fats are converted to soaps, a chemical substance known as glycerin is always obtained along with the soap. Glycerin is transformed by nitric acid into another dangerous explosive, nitroglycerin. Glycerin is also of value as a sweetening agent and as a skin softener in many cosmetics.

Glass. The ordinary bottle or window variety of glass is made by fusing (melting) a mixture of sand (SiO_2), sodium carbonate (Na_2CO_3) and lime (CaO). By adding other chemical substances to this mixture, different kinds of glass are obtained. Pyrex glass, famous because it will not break when heated, is made by adding compounds of boron and aluminum. It is used to make cooking utensils. Many houses and office buildings are now constructed in part from glass brick. The lenses of eyeglasses, microscopes, telescopes and many other delicate instruments used by man in seeking out nature's secrets are made from



Courtesy, Aluminum Company of America

Pouring molten aluminum metal into cast iron molds. Each block of metal, or pig, weighs about fifty pounds.

another kind of glass called optical glass. By the addition of very small amounts of certain chemicals, generally a metallic compound, glass of almost any desired color can be obtained. When hot, glass can be "spun" into the finest of thread, and woven into cloth.

Metals are rarely found in nature in their pure form. They are almost always found in the earth as chemical compounds, or ores. The desired metals are extracted from the ores by a combination of chemical changes known as smelting. Oxides—compounds of metals with oxygen—are very important ores. Compounds easily transformed into oxides by roasting are also important ores. Metals can be set free from the oxygen in the compound by heating them with carbon in the form of coke or anthracite coal. The oxygen leaves one partnership and forms another. That is, it combines with the carbon; and so the metal is free. Impurities present in the ore are removed by addition of a "flux," generally limestone ($CaCO_3$). The flux combines with the impurities, forming a liquid—slag—which floats on the surface of the molten metal and can be easily removed.

These operations are carried out in huge furnaces, or smelters, which vary in construction with the type of ore used. The Story of Iron and Steel tells you some of the ways in which iron ores are treated. Electricity aids in the extraction of many metals from their ores—copper, zinc, aluminum and magnesium, and others. We tell you about the process in the article on Aluminum. The use of electricity in chemical processes is called electrochemistry. Electrochemistry is likewise used to purify (refine) many metals obtained by the smelting process.

Courtesy, Coty, Inc.

Chemistry plays a large part in making this perfume, the glass bottle and stopper and the box with its synthetic lining of rayon.

Courtesy, Bakelite Corporation

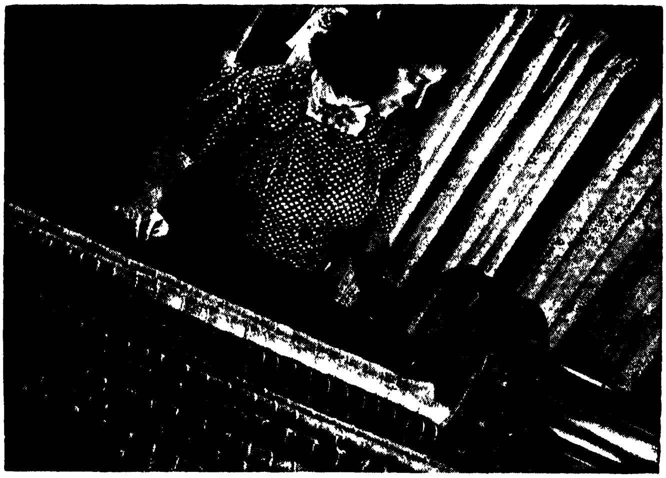
Phonograph records of Vinylite plastic.

Alloys. When we get the pure metals, few are right for our use without some change. Some are too soft. Some are hard, but brittle. Many rapidly corrode, or rust, if exposed to air and moisture. Man has learned how to overcome these things by combining the pure elements with one or more other elements. Such metallic compounds, called alloys, often possess remarkable properties. Steel is an alloy of iron. With carbon, manganese, chromium, nickel and other elements, iron forms different kinds of steels which are lighter, stronger and more resistant to rust than iron. Railroad cars, locomotives, and their thousands of miles of rail, tools of all sorts, knives, machine tools, farm implements, cables for elevators and suspension bridges, springs and building supports are made from suitable steels.

You know hundreds of other alloys. Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc. Pewter is an alloy of tin and lead, or tin, copper and antimony, or sometimes a little silver is used in the mixture. An alloy, of lead, antimony and tin makes type-metal, used to set this book in type. The solder your plumber uses is an alloy of tin and lead. What we call German silver, or nickel silver, has no silver in it at all! It is an alloy of copper, zinc and nickel. You have seen Monel metal, so much used for kitchen sinks and other kitchen ware, window screens, propellers of ships and other devices. This is an alloy of several elements—nickel, copper, iron manganese, carbon and silicon, carefully mixed in exact proportions.

Other alloys—made-to-order metals—are low-melting alloys for electrical fuses and automatic fire extinguishers, and so on. Alloys of aluminum and magnesium are of special importance. They are amazingly light and yet very hard and very strong. They have replaced steel in airplane motors and other parts. The gleaming, silver-bright streamlined trains which travel through the country at record speed are constructed largely of these alloys.

Coal-tar products. The coke required for smelting ores is produced by heating soft, or bituminous, coal in specially designed ovens. An oily liquid called coal tar is always obtained along with an inflammable gas



Courtesy, du Pont Company

Nylon being prepared for use as bristles in toothbrushes and hairbrushes.

called artificial, or illuminating, gas. By chemical treatment, benzene, toluene, phenol and other organic compounds are obtained from this tar.

These simple compounds are now also obtained from petroleum and other sources. From them are made thousands of useful products—dyes, perfumes, medicines, explosives, synthetic rubber, plastics.

Dyes were formerly obtained from plants and animals. Tyrian, or royal purple, was obtained from a tiny Mediterranean shellfish gathered by daring Phoenician sailors. Madder root furnished the dye for the bright red uniforms of the British soldiers, the "red coats." Indigo was extracted from the indigo plant. These colors and thousands of others of every imaginable tint and shade can now be made from coal tar.

Polymers. Synthetic plastics, or resins, are produced by an interesting type of chemical reaction called polymerization. Molecules of one or more substances, hundreds of them, unite with one another in definite patterns to form super-molecules of a new substance, called a polymer. The process can be likened to a group of people forming one long line or closed circle by clasping hands. Plastics are polymers and are of a variety of types. Their properties are as varied and unpredictable as those of the alloys. Some are strong and tough, resembling the metals, while others are as clear as glass and even possess optical properties. Bakelite is a plastic made from phenol and formaldehyde. It is a poor conductor of heat and electricity, and is used for insulating materials, for handles on cooking utensils, handbags, brushes, buttons and bottle caps, for telephone receivers and radio parts. Lucite and Plexiglas are crystal-clear plastics from which "non-breakable glass" for airplanes and automobiles is made. Rods made from these plastics, unlike ordinary glass rods, will transmit or conduct light from a hidden source even when bent or curved. They are used to produce unusual lighting effects and to make medical and dental lamps.

Nylon is one of several plastics which can be spun into fine threads and woven into fabrics. The nylon stockings so highly prized by women are made this way. Nylon material is easily waterproofed; so raincoats are made of nylon. It is also used to make bristles for brushes. This man-made fiber is created from coal, air and water. Waterproof and moldproof window and shower curtains are now made from plastic materials.

Synthetic rubber is a plastic with rubber-like properties made from substances—styrene and butadiene—obtained from coal and petroleum. Synthetic and natural rubbers are complex hydrocarbons.

Natural rubber is one of nature's plastics, or polymers, and is obtained from the "milk" (latex) of certain trees and shrubs. To make it stronger, tougher and more heat resistant, it is heated with small amounts of sulfur. This process is called vulcanization. Rubber is used to make tires, boots, shoes, coats, elastic material for use in garments, and hard-rubber items of all types. For some purposes synthetic rubber is better than natural rubber, but it will be some time before it can be produced as cheaply as natural rubber.

Petroleum chemistry. Petroleum is found in the earth as a brown to black viscous oil. From it chemistry has enabled man to reap enormous riches in gasoline, kerosene, lubricating and fuel oils, vaseline, paraffin wax and hundreds of other valuable products. "Oil" (petroleum), like gold, signifies wealth.

Petroleum is a mixture of simple and complex hydrocarbons. Naphtha, gasoline, kerosene and lubricating oils are separated from this mixture by a process called distillation.

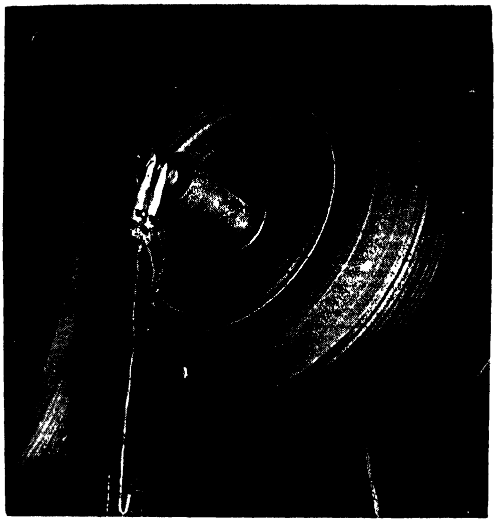
Then they are further purified, or refined, by chemical treatment. In the days before the automobile, before electric lighting and electric heating, kerosene was the most valuable petroleum product. Lamps that burned kerosene were used for lighting. Kerosene stoves (called oil stoves) were used for cooking and, to some extent, for heating. The gasoline was considered practically worthless.

Today the demand is for more and more gasoline for automobiles and airplanes. The hydrocarbon molecules of gasoline are rather short while those in kerosene are two, three and four times as long. When heated to a high temperature the long molecules in kerosene are broken up into the smaller molecules found in gasoline. By this "cracking" process, gasoline is now made from surplus kerosene. The so-called high-octane or 100-octane gasoline used in airplanes is made by blending specially prepared chemicals with ordinary gasoline. Chemists are now experimenting with coal and natural gas to produce more high-grade gasoline.

Carbohydrates—sugars and starches—are familiar foods. Man can not live without them. Sugar is obtained from cane and beets, while starch is obtained chiefly from corn, potatoes and wheat. Chemistry plays an important part in extracting these substances from plants and preparing them for use as foods. Carbohydrates are also important raw materials from which alcohol, synthetic rubber and rayon, paper, adhesives (glue) and explosives are produced.

Fermentation converts the starch present in grains and potatoes into alcohol. Large quantities of alcoholic beverages are produced in this way. Still larger quantities of alcohol are used for better purposes. Grain alcohol is an antiseptic. That is, it kills germs. Many medicines contain some alcohol. Air and water convert grain alcohol into vinegar or acetic acid. From alcohol and other fermentation products many useful substances are made. Synthetic rubber can be produced from carbohydrates as easily as from petroleum.

Cellulose is the carbohydrate which forms the bulk of most plants, especially the stalks and stems. It has no food value for man, but other animals thrive on it. Cotton is a form of cellulose. Man not only depends on carbohydrates for food, but for clothing as well. Cotton, wood, cornstalks and other cellulose materials are used to make paper, rayons and cellophane and many other products.



Courtesy, Firestone Tire & Rubber Company
Testing synthetic rubber tires in the laboratory.

In one process for making paper, pine logs are shredded by powerful machines and then boiled with a chemical called calcium bisulfite. This treatment removes impurities. The pulpy mass of pure cellulose fibers that remains is rolled into thin sheets, dried and further treated to produce the paper.

To make artificial silk, cotton and other cellulose materials are made into liquid substances by chemical treatment. When these liquids are sprayed through fine nozzles into the proper chemical baths, the cellulose comes out as long lustrous threads resembling silk. Rayon garments are woven from these threads. If the liquid cellulose is forced through long fine slots, the cellulose is obtained in thin transparent sheets called cellophane.

We can not let the curtain fall on this drama of chemistry in the world of today without a glance at the world of tomorrow. With the discovery first of radioactive elements, and then neutrons, protons and electrons as the building units for the atom, it soon became apparent that a way existed for changing one element into another. Huge machines called cyclotrons were built to study the possibilities, and from their use man received an inkling of the unbelievably enormous quantities of energy locked up in the tiny atom. The key to this lock, the key to atomic energy, has been discovered. Mankind is looking forward with anxiety and awe to the new era which we are about to enter.

By LAWRENCE H. KNOX.

THE NEXT STORY OF SCIENCE IS ON PAGE 5661.

HOW WE GET WOOL

Courtesy, Idaho State Chamber of Commerce, Boise

A sheep ranch in Eastern Idaho. The United States and Canada together produce more than 450,560,000 pounds of wool each year, which is about one-seventh of the world production.

Courtesy, New Zealand Government

Merino sheep (originally from Spain) give fine, soft, silky wool fibres. Most of the sheep raised for wool are merinos or have some merino blood. Here is a flock of merinos on a sheep station in New Zealand.

Courtesy, Charles Belden

WOOL AND ITS STORY

WHEN we see a picture of a savage clothed in a leopard-skin, or of a lady wearing a sable coat, we quite understand that both these people, so far removed in character and country, are clothed in the coats of animals; but when we put on our ordinary clothes in the morning, do we remember that we also are putting on an animal's coat?

Our outer clothes and often our inner ones are made of wool, and wool is a product of the sheep. Though we can imitate its appearance, we cannot find a real substitute for it.

Wool is really a living part of a sheep; it is produced by the epidermal cells. The difference between wool and hair is that the wool fibre has a covering of pointed scales, or plates, overlapping like fish scales and attached to the fibre at their bases. This scaly coat càn be seen through a microscope. If a wool fibre is drawn through the fingers a certain roughness can be felt. The overlapping scales, when brought together at an angle, tend to mat together, or "felt." That is why the wool of the sheep is different from all other fibres, animal or vegetable. Among other extremely valuable characteristics of wool fibre are its resilience and elasticity. These properties not only give a soft texture to cloth made of wool, but they also provide strength and resistance to wear.

It is estimated that there are over 640 million domesticated sheep in the world, and all these are producing wool that is taken from them once a year and woven into cloth to keep us warm. This involves no cruelty to the sheep, for it is the same thing for the animal as hair-cutting is for us. The wool soon grows again, and as the shearing is done in spring, when the weather is warm, the animal does not suffer from the cold in any way, but is relieved of its burden.

As man, by careful selection and breeding, has produced hens that lay two hundred or more eggs a year in place of the few laid by the original jungle fowl of India, from which our hens are descended, so he has carefully selected sheep with the best coats and has gradually produced a race of animals that now yield on an average nearly twice as much wool as sheep yielded not many years ago.

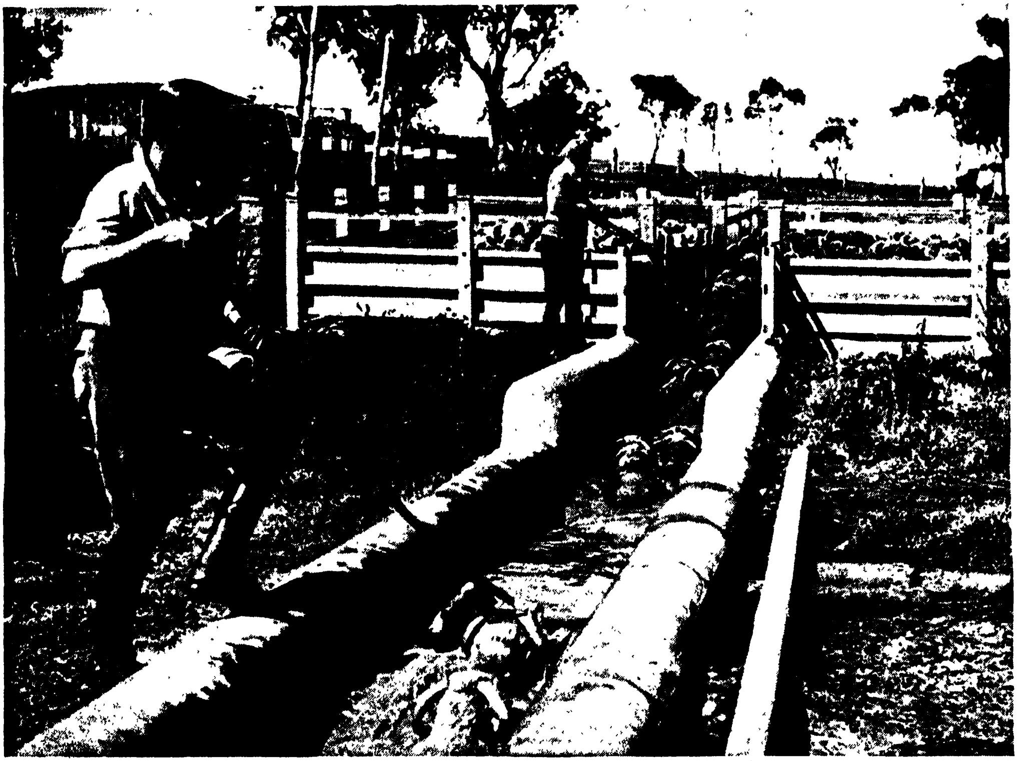
That is a triumph of scientific stock-breeding, and means not only that we get more and better wool, but that wool is made cheaper, because when the quantity of anything is greatly increased, its price falls.

All sheep do not yield the same quality

of wool, and even the same kind of sheep will produce better wool in one country than in another. The difference is caused by climate and soil. Sheep reared in Australia produce a finer wool than the same kind of sheep brought up in England.

Where wool rather than mutton is desired, merinos are generally kept. The merinos come from Spain, and in the eighth century they were mentioned as providing wool which the conquering Moors made into cloth. As the centuries passed, the breeding of merinos spread to other European countries. In 1797 some merino sheep were taken to New South Wales, where the hot dry countryside suited them so well that they are now the leading sheep in Australia. It is known that in 1801 a man named Seth Adams brought a pair of merinos to the United States, and the great flocks of the western states are of that breed. So, too, are the Argentinian flocks. In Canada the mutton or the general-purpose breeds are more popular. More Canadian wool is raised on farms than on great specialized ranches.

A good ewe sometimes yields fifteen pounds of wool, while a ram yields from twenty to thirty pounds, though the average is much less. Some kinds of merinos have wrinkled skin, which gives more space for wool-bearing, and as a result a bigger yield. There are from 16,000 to 61,000 fibres to the square inch of skin on a merino.



© Ewing Galloway, New York

Sheep suffer from a skin disease known as scabies, or scab. To keep the animals healthy they are dipped, that is, they are sent through a bath containing a liquid that kills the parasites.

The wool, or fleece, from a merino is much finer than that from English breeds of sheep, and the diameter of a fibre of merino wool may be one-thousandth or even one two-thousandth part of an inch. Such a fibre is crimpy, strong, silky and slightly oily. The oil protects the fibres, or hairs, at the roots. Sometimes dust is caught in the oil at the outside tips of the wool fibres; then the sheep looks dirty. The oil is scoured out of the fleece, and we have the white and glistening soft fibres left.

Among the other wool breeds which are important on this continent are the Delaine and the Rambouillet. Both are of the merino family, but the wool is somewhat different. Delaine comes from two French words meaning "of wool." Delaine fibres are long and can be combed and spun to make strong, warm cloth. The Rambouillet sheep has coarser wool.

Australia and New Zealand sheep are good wool-bearers, giving an average of almost nine and a quarter pounds per animal. Some American breeds have even heavier fleeces.

Australian wool is now among the finest in the world, and there is a great demand for it. Australia possesses more sheep than any other country and Russia is next. In quantity and quality of wool produced, Australia is easily first, followed by the United States and the Argentine Republic.

How long the sheep's wool has been woven into fabric we cannot tell, but the practice is very old. Though the ancient Egyptians as a race did not wear woolen garments because their climate was warm, we know that some of them did wear wool. As far back as history goes and, still farther, the production of wool has been a great industry, for almost from the beginning men have kept large flocks of sheep as part of their wealth. The Bible is full of references to sheep and wool. Virgil, the Roman poet, knew all about the ins and outs of sheep-farming, and his descriptions of the work of the shepherd might almost have been written to-day about the big sheep-stations of Australia.

England's prosperity in the Middle Ages was built up largely on wool, as sheep-farming was the principal national industry. English sheep produced fine wool that was exported to the Continent, and there was woven into cloth, chiefly by the skilled weavers of Flanders.

Later, Flemish weavers went to England, and the woolen manufacture grew up, encouraged and protected by the kings as a source of revenue. Edward III, for instance,

Motor-driven machine shears are used to-day in many parts of the world. Sheep are sheared in the spring.

Australia Press Bureau Photos

An expert shearer with machine shears can clip up to 300 sheep in a day; 130 to 160 is, however, the average.

prohibited the export of wool from England, and he also forbade the importation of fine woolen cloths from Flanders, his purpose being to deprive foreign competitors of their raw material and to encourage the English weavers to produce the better and finer kinds of cloths they had before neglected.

After a time the weaving industry became very important, and the splendid parish churches of East Anglia, almost like cathedrals, are a testimony to the wealth and prosperity of that part of England, which was the first seat of the woolen industry.

The first record of the manufacture commercially of cloth in the United States from wool is that of a fulling mill at Rowley, Massachusetts. This mill was built "by Mr. Rowley's people, who were the first that set upon making cloth in this Western World." At the close of the eighteenth century the factory woolen industry was established in the United States. At present there are about 700 mills engaged in the various phases of the woolen industry. These include scouring, carding and combing of the fibres, yarn spinning, and the weaving of worsted or woolen cloth as well as the manufacture of woven felts. About seventy establishments make wool carpets and rugs.

The manufacture of woolen cloth in Canada commenced soon after the arrival of the earliest colonists. Intendant Talon reported in 1671 that the colonists were making practically all articles of clothing required. Many of the large woolen mills in Canada to-day are the successors of the small carding plants then operated in connection with a grist-mill or a sawmill. In the province of Ontario in 1820 the Honorable James Crooks founded a mill near Georgetown.

Wool is woven into two distinct kinds of cloth, one called woolen cloth, and the other worsted. The difference is due to the way the thread, or yarn, is prepared. Each has its advantages. In the manufacture of worsted the wool is combed to produce strands of the longer fibres known as "top."

© Ewing Galloway, New York

A flock of sheep in Colorado, after shearing. The world's production of wool amounts to around 3,500,000,000 pounds a year. More than a quarter of this amount comes from Australia which leads all other countries.

Australia Press Bureau Photo

The wool is sheared off in a single sheet, or fleece, that still holds the shape of the sheep's body. In Australia, the fleece goes through several processes in the shearing shed before it is ready for the international market. The expert, shown above, is grading it for length of staple, spinning quality and other points. Then the wool of each grade is packed in bales of about 300 pounds.

The purpose of this combing process is to do away with the shorter fibres and to arrange the long fibres in such a way that they will lie parallel in a long strand. The tops are then drawn into finer strands called "roving," which are then spun and twisted into yarn. In the manufacture of woolen yarn the fibres are not combed parallel as is the case with worsted yarn. Instead, the fibres are made to cross and mat together.

The question is sometimes asked why a wool garment keeps us warm when a cotton or a linen one does not. There is always a great deal of air between the hairs, or wool-strands, on an animal's back, and the fluffier the wool is, the more air is held by it. Heat finds it very difficult to get across a layer of air, because air is a bad conductor. So, whether the wool which holds a layer of air is on the animal's back or on our back in the form of clothes, it keeps the body warm by the way it prevents the body heat from passing off into the atmosphere.

As a matter of fact, a wool garment will keep us cool in summer as well as warm in winter, for just as it prevents the heat of the body from passing out, it prevents the heat of the sun and air from passing in. That is why the iceman sends his ice through the streets covered with a thick blanket. He thus saves it from being melted by the sun.

It is not sufficient, however, that a material should prevent heat from passing through it—rubber would do that—but it must be porous so that the outside air and the inside air can mingle to some extent. In this way the perspiration produced when we exert ourselves at work or play evaporates slowly.

In a changeable climate it is important that we wear wool next to our bodies to save us from sudden chills that are so harmful to health. Let us remember, many of us owe our health to the sheep that supply us with wool for our underwear, suits and dresses, sweaters and overcoats.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5699.

THE WOOL GOES TO MARKET

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Above. Wool for carpets and rugs manufactured on this continent comes from abroad. Coarse, powerful wool from hardy sheep is required. Fleeces from Mongolia are brought by camel-back to the railroad, then by ship.

Australia Press Bureau Photo

Left. Graded and carefully packed Australian wool goes to market by truck or sometimes by bullock cart.

Courtesy, New Zealand Government

Buyers come from all over the world to the wool selling centres of Australia and New Zealand. Here are some bales being transferred from trucks to a ship bound for some distant port.

IN THE WOOL WAREHOUSE

In America, wool fleeces, as soon as they come from the sheep, are put in bags and sent to warehouses where the grading is done. Here the men in the background can be seen picking over a pile of fleeces.

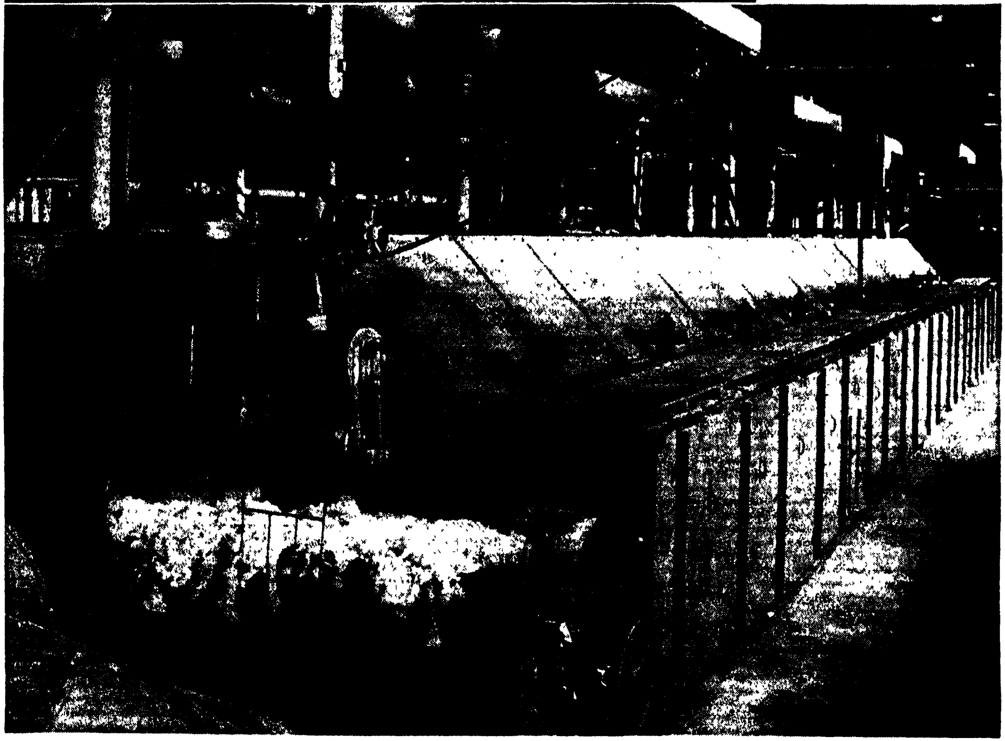
Pictures, courtesy, American Wool Council

Large bags of the same grade of wool are stored in stalls with the number indicating the grade marked above. Manufacturers of blankets, woolen cloth and other goods select the grade, or grades, that suits their particular needs.

THE WOOL REACHES THE MILL

Botany Worsted Mills

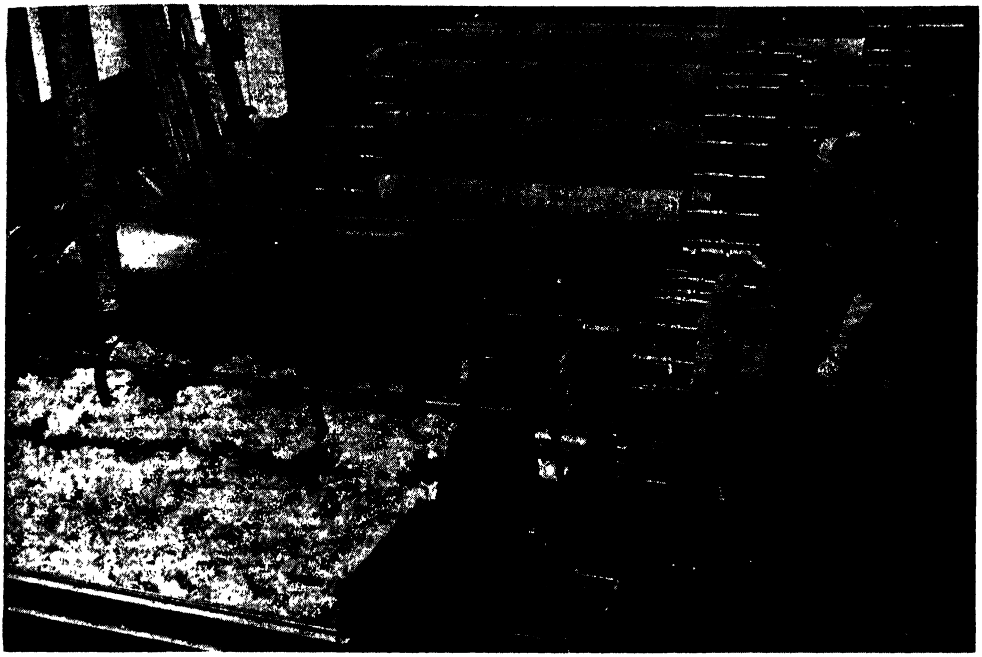
When it arrives at the mill the fleece is torn apart, and wool from the different parts of the body put into separate baskets.



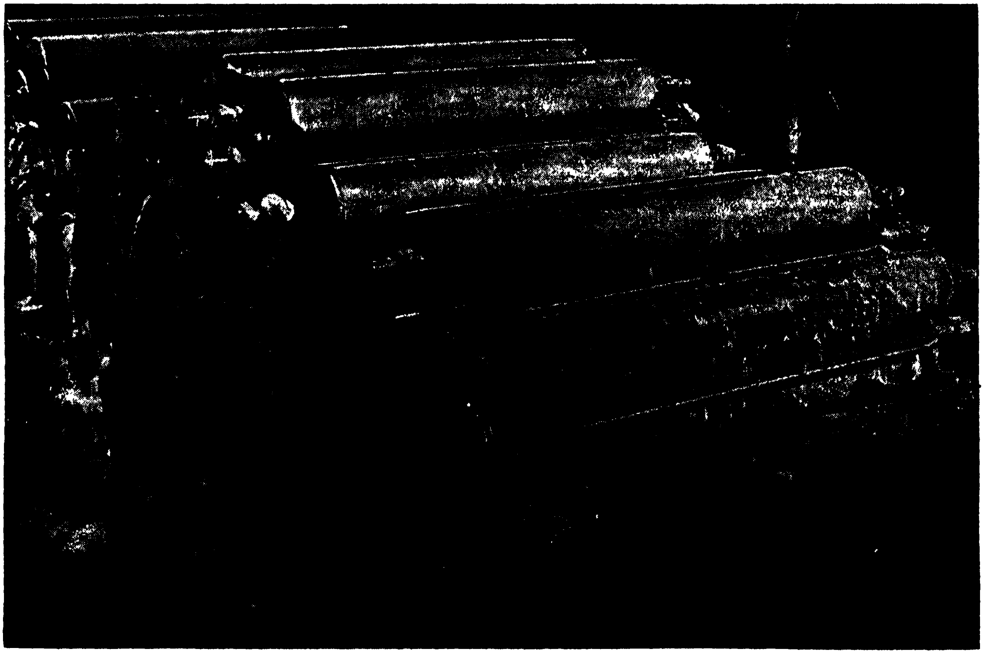
© Ewing Galloway, New York

Next the wool of each class is passed through various cleaning and washing (scouring) operations to free it from grease and other impurities and then passes on to the dryers.

PREPARING WOOL FOR THE WEAVER

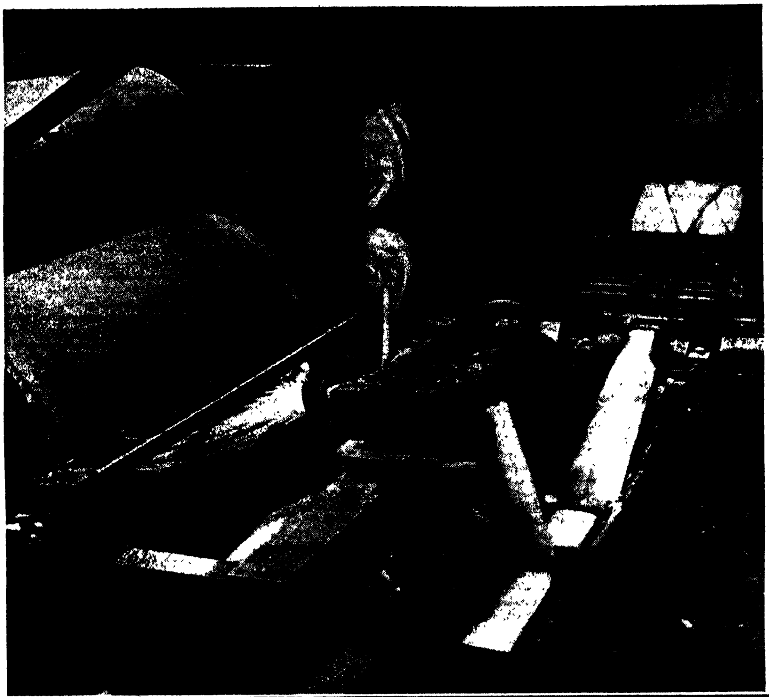


Next come the carding machines where the wool is passed between revolving cylinders with wire teeth which open up, separate, and straighten the fibres, so that they lie in a uniform film.



Pictures, Botany Worsted Mills

The fibres are usually carded more than once. Besides arranging the fibres this process takes out some impurities and also many fibres that are too short to spin. Other uses are found for these.



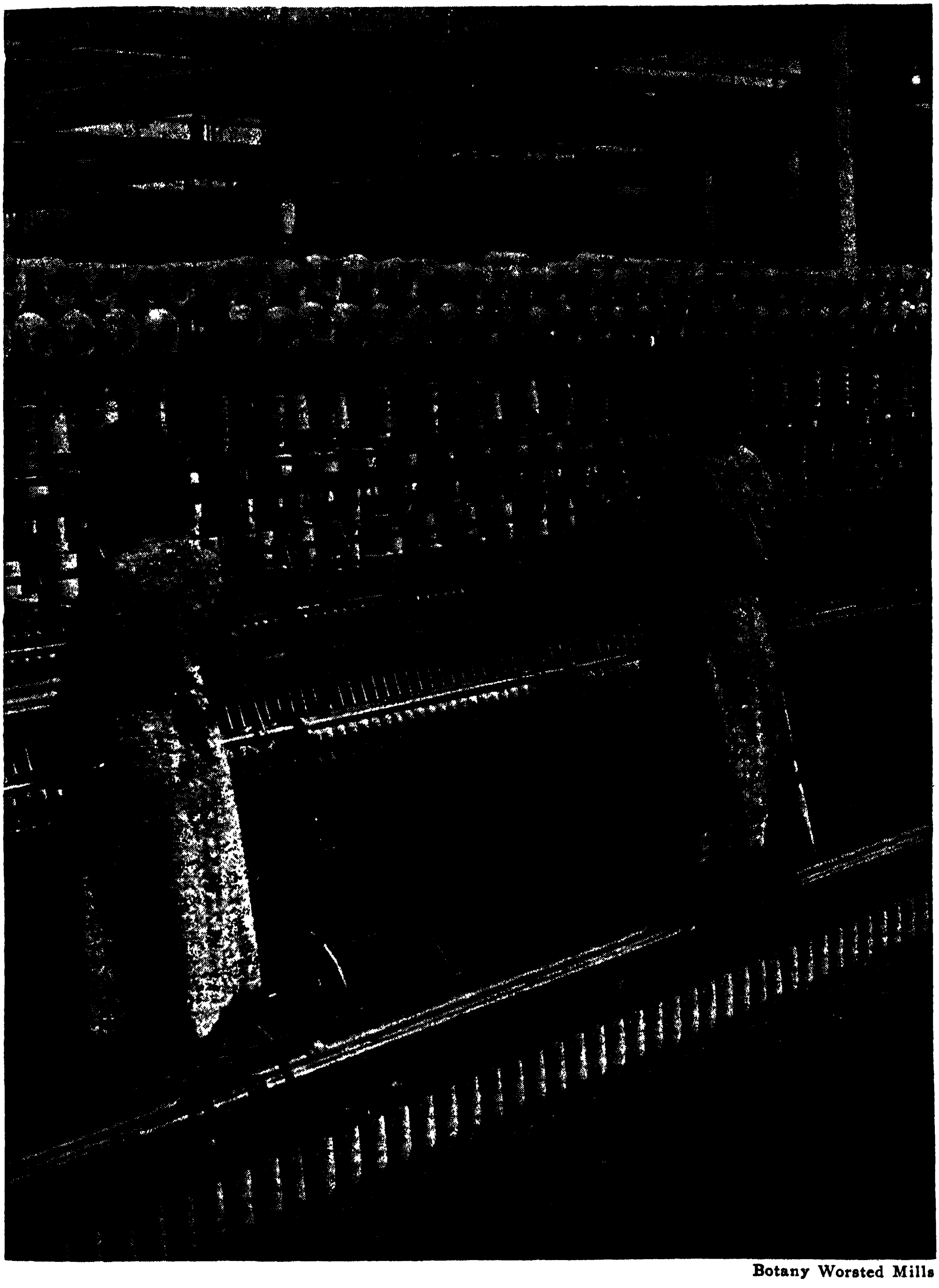
ROVING AND COMBING

Left. For woolen cloth the sliver is then drawn into light strands, called rovings, about one-eighth of an inch in diameter, and is then ready for the spinning machine.

Below. For worsted materials the roving is combed several times before it is spun, until the fibres lie smoothly side by side, and the short ones are removed. Woolen cloth has a soft appearance and a sort of cloudy woven appearance, whereas worsteds are more evenly woven and have a more clearly defined pattern.

Botany Worsted Mills

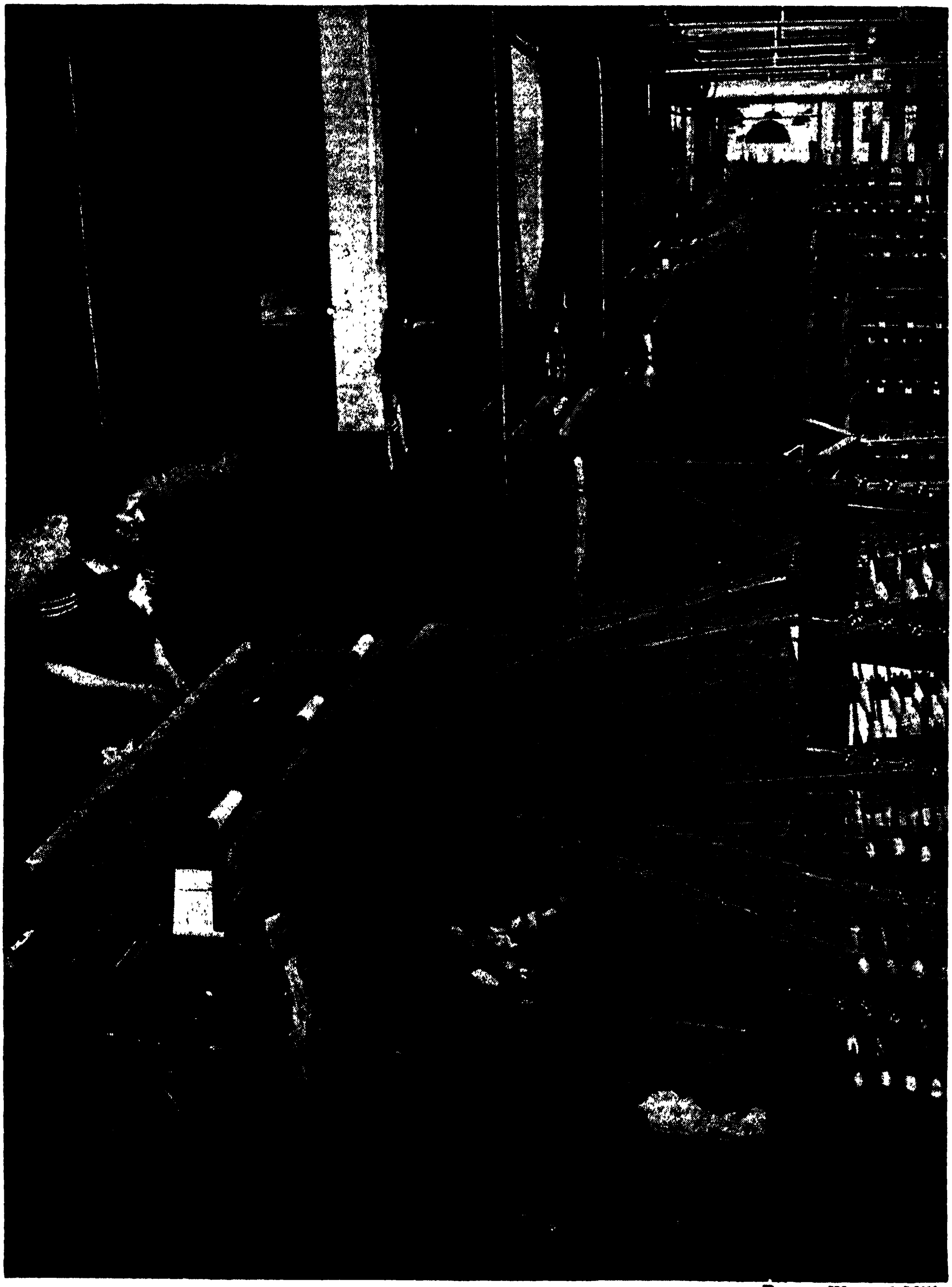
SPINNING RAW WOOL INTO YARN



Botany Worsted Mills

The roving is wound on spools and goes to the spinning room. The most commonly used machine for spinning is the mule, seen here. It pulls out and twists the wool into a soft, rather loose yarn. Two or more strands of yarn may then be spun or twisted together if a coarser strand is desired.

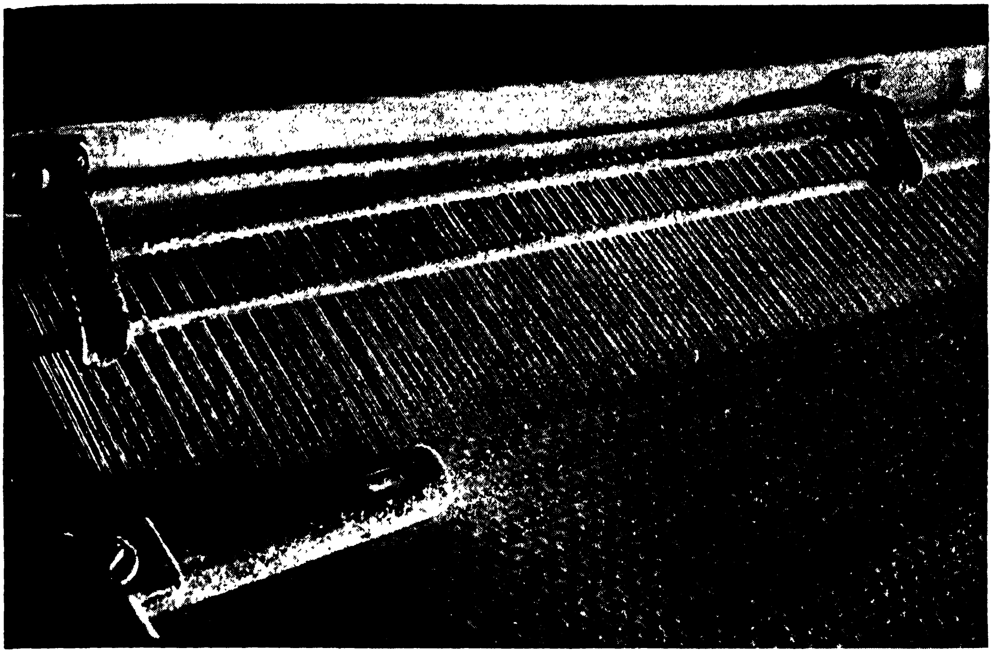
THE PROCESS OF WARPING



Botany Worsted Mills

The warping process next follows. Every piece of cloth has two sets of threads, one running lengthwise, called the warp, and the other crossing those, the weft. The warp threads are here being wound on a drum which will feed the loom. Warp threads for a number of pieces are generally wound at one time.

WEAVING AND DYEING THE CLOTH



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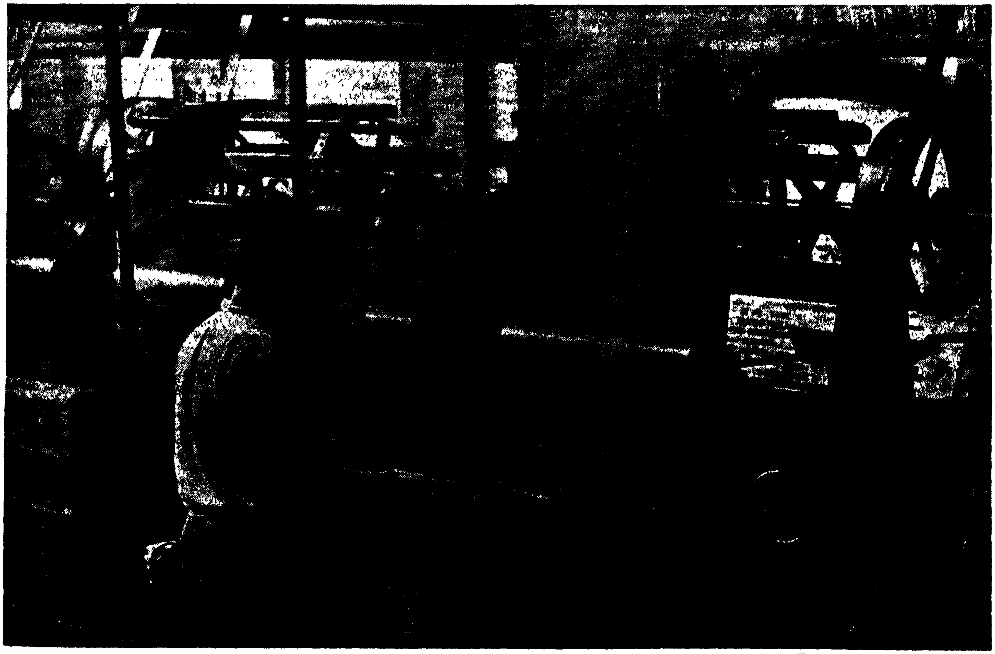
This is a near view of weaving. The warp threads having been arranged, a shuttle containing the weft busily works back and forth until yard after yard of the cloth is woven.



Botany Worsted Mills

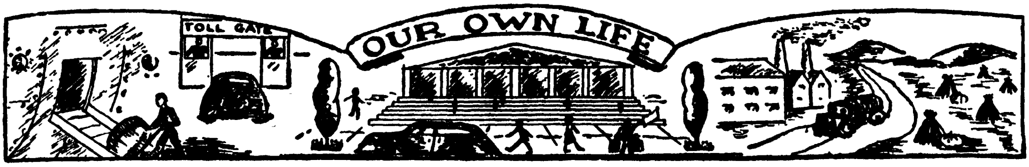
Sometimes yarns are dyed before weaving, especially if striped material or material of mixed shades is to be made, but cloth of one color is usually dyed in the piece.

FINISHING THE CLOTH

The cloth is washed and fulled, that is, it is saturated with water containing fuller's earth.

All pictures from Botany Worsted Mills, courtesy, American Wool Council

The cloth is stretched, pressed and examined in one machine. On some materials, such as suede, the nap is brushed with teasel-heads. To secure an even nap, the cloth is sheared by running it through a shearing machine which works something like a lawn-mower. Finally it is rolled on boards or bolts for shipment.



MONEY *and* WHY WE USE IT

BEFORE the invention of money, thousands of years ago, people exchanged things directly with each other. A man gave a cow for a horse; he gave a pottery jar that his wife had made for some eggs or a string of fish. This method of exchange, or trade, is called barter. There are still a few parts of the world inhabited by uncivilized tribes where trade is carried on in this way.

Let us try to imagine what life would be like if we used the barter system of trade in place of money. Suppose, for example, that your father manufactures dining-room tables which he hopes to exchange for an automobile, a suit of clothes and many other things. He will at once be confronted by several problems. To begin with, the automobile dealer may not want the style of table your father makes. Likewise, the clothing merchant may have no use for a dining-room table. Suppose the cost of the automobile is equal to ten tables, and one table is worth two suits; but the automobile dealer wants only one table, and your father wants just one suit. It will do no good to cut a car and a table in pieces and try to exchange the pieces.

In a community where every family produced most all the things it needed to live and get along, a barter system of exchange might be satisfactory. For example, little, if any money was needed in the early days of civilization, when most people lived on the land. Every family provided practically all its own needs for food, shelter and clothing, so there was not much trade of any sort.

However, as towns and cities sprang up, the economic life of the people changed. Individuals and families began to specialize in occupations. One family, for instance, would devote itself to raising grain, another to raising cattle, another to grinding the grain of the neighboring farms and converting it into flour, another to making shoes, and so on.

In this manner arose the several perplexing problems of exchange which led to the invention of money. Through its use we all can readily exchange our work, or the products of our work, for the labor or products of others. How wonderful was the invention of money and how far-reaching its influence on the everyday life of the world!

The beginning of money was simple. People in a certain area agreed with each other to recognize some particular articles as a gen-

"A lean goat for a fat pig?" The dame seems to think it a fair exchange, but the animals are not so willing!

eral standard of value. Many different things came to be used as money from time to time. A man's wealth came to be reckoned, as we find recorded in the Old Testament, by the size of his flocks and herds. So, among the earliest standards of value we find cattle; and cattle were actually used as money. Grain, however, was a much better form of money because it could easily be divided into small quantities. A live animal could not be. Many other things came to be used as money in the early days, as for example, bars of iron. Only a few hundred years ago shells were used for money and later, furs, by the American Indians. The Virginia colonists used tobacco. But let us go back to an earlier day, when the world was young.

As civilization advanced and metals came into use, they became more and more used as money. Especially was this true of the rare metals. Gold and silver were not only rare, but were universally desired for their beauty. Everyone was willing to accept them in exchange for any other goods they had. Moreover, these metals were not only rare, but almost indestructible, and easily divided into pieces of any size, so that a little piece might be exchanged for a loaf of bread or a pound of meat, a large piece for a horse or a suit of clothes, or a still larger piece for a house.

IN BUYING AND SELLING, MONEY IS A MEASURE OF VALUE

Already we have seen that money acts as a standard of value. When we change our goods for money we are said to sell. When we change money for goods we are said to buy. This buying and selling through the use of money enables us to speak of things as being *worth so much money*. Thus money conveniently measures value by a common *standard*. This measure of value by money we call price. The price of an article is its value expressed in money.

Let us go back now to the imaginary case of your father. Money measures the value of his tables; that is, your father sets a price on his tables. Automobiles have their price, and suits also. Your father can sell his tables to those who want them at the price. When he has sold ten tables to ten different people, he has the price of an automobile. When he has sold one table he has the price of a suit, and has some money left over. Your father has exchanged his goods for the goods he wants, not directly, but by the medium of money. Money is a *medium of exchange*. When we know that our money will buy more of this or less of that, we are greatly assisted by prices in deciding what to buy and what to sell.

Money also serves as a *storer of value*. Upon receiving payment to cover the sale of some of his tables, your father may not wish to spend all of it right away. A portion of it will probably be put in the bank until he has use for it. Meanwhile, he knows that those dollars put away will buy approximately as many groceries, pairs of shoes, suits of clothes, or government bonds next week or even next year as they will today. Thus money also serves as a storer of value.

FOR CENTURIES GOLD HAS BEEN USED AS A STANDARD OF EXCHANGE

Very early, gold came to be adopted by nearly all civilized countries as a standard money. It is not only rare, but stable in value. It is almost indestructible, and loses none of its value by being divided into small coins. It is everywhere desirable and confidently accepted. A small piece is of high value, so a considerable amount of money in gold can easily be carried. It is not too heavy or bulky to carry around—not like cattle, for instance.

The standard coin of both the United States and Canada is the gold dollar. Both countries issue silver dollars also, but they are rather large and heavy, and many people prefer the convenient dollar bills.

The other coins we use—silver, nickel and bronze or copper—are merely tokens and are coined for convenience in small transactions. We could not use gold quarters or gold cents because they would be absurdly small. Even when five-dollar gold pieces were issued they looked very much like bright new pennies and were sometimes mistaken for them.

Different countries use different units of money. Here is a table which shows the approximate value of the money of certain countries.*

Country	*Money Unit*	*Value in U.S. Dollars, 1949*
Argentina	peso	.25
Belgium	franc	.02
Canada	dollar	$1.00
Australia	pound	$3.21
Netherlands	guilder	.37
Brazil	cruzeiro	.05
Denmark	krone	.20
United Kingdom	pound	$4.03
Italy	lira	.001739
Portugal	escudo	.04
Sweden	krona	.27
France	franc	.004671

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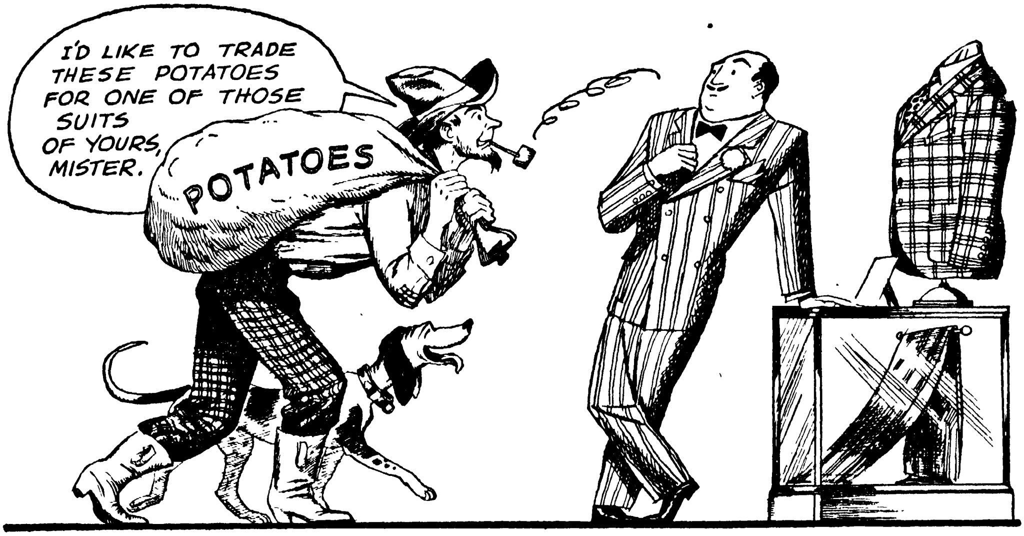
*Federal Reserve Bulletin, March 1949.


I'D LIKE TO TRADE THESE POTATOES FOR ONE OF THOSE SUITS OF YOURS, MISTER.
POTATOES

I'M AFRAID THIS IS ALL WE CAN ALLOW YOU IN EXCHANGE, SIR.
POTATOES
ROGER VERNAM

Paper money is included as part of the monetary (money) system in all civilized countries. As long as a country keeps gold, or the ability to buy gold, as backing for the paper money which it issues, the paper money is as good as gold, because the holder is able at any time to change it into gold. However, let us suppose the paper money of a country can not be exchanged for gold, since the country does not have enough gold. Even then, if the amount of paper money issued is not too large, that is, if only enough is printed to serve the country's needs, prices will not change much from day to day.

Sometimes governments, as during and following the first World War, faced with the terribly high expenses of carrying on the campaigns and dealing with the difficulties which arose after the Armistice, resorted to the plan of printing very large quantities of paper money, so that the countries were flooded with paper money. This was especially true in France, Germany, Italy, Russia and Austria. They kept printing more money, instead of putting the national finances in order. However, as more and more paper money was issued, its value fell rapidly and people had less and less confidence in it.

As each fresh batch was printed, the prices of goods rose, which really meant that the money was worth less. That is what we call inflation. When there is inflation, people lose faith in the country's money. As we have seen, there can not be confidence in money unless it is generally recognized as a standard of value and accepted as a medium of exchange.

WHAT IS MEANT BY "GOING OFF THE GOLD STANDARD"

Some years after that war several governments, Great Britain for example, called in some of their paper money, saved up stocks of gold and "resumed specie payments." That meant that the paper money left in circulation was as good as gold, and could be exchanged for gold at a bank. The supply of gold in the world, however, is very small. Great Britain did not have enough to continue giving gold for notes. However, the supply of paper money did not greatly increase, and so it was not really bad money. The United States, in 1933, also stopped giving gold for notes. This is called "going off the gold standard."

Good paper money, then, may be exchanged for gold, or else the quantity is so restricted that prices do not change very much from day to day. Such protected paper money is often called a "managed currency."

Bad paper money, such as the German mark or the Russian ruble in 1924, is called "inconvertible notes" because gold can not be obtained for them, and because their value consists merely of what they will buy in the market, their buying power falling as the number of such notes increases. In Russia the Soviet Government at one time in its early history issued so much paper money that a printed note was worth less than the same amount of blank paper. Soon after the beginning of World War II in 1939, some of the warring nations again began to issue excessive amounts of paper money. The result was that prices began to rise very rapidly. In some cases the rise was as much as 500 or 600 per cent.

When a nation has good money, and when, as a consequence, there is perfect confidence in the national money, *we are able to do most of our business without using money at all.* This, fortunately, is the privilege enjoyed in Canada and the United States.

It is only in small transactions, such as when buying our groceries, that coin is much used in our country. In all big transactions connected with wholesale buying and selling, and finance, and in a great deal of retail buying, we do not use coins or paper money, but just *pieces of paper on which we have written a promise to pay.* Such a paper promise to pay is called a *check.* A man can pay a debt by giving a check when he has in a bank at least the amount of money written on the check. We say the check is drawn on the bank. The bank pays the money out of the fund it is keeping for the man who signed the check. Thus a check is as good as money, if:

1. The bank upon which the check is drawn is sound and reliable.
2. The nation's money is stable in value.
3. The firm or person drawing the check has the amount of money stored in that bank.

When these things are true, the check, when signed, becomes a magic piece of paper as good as gold.

Every day tens of thousands of individuals and business firms are sending checks, or paper promises to pay, to other thousands. The checks are paid into the banks and the banks have a central office called a *clearing house.* There the checks are sorted and balanced. Thus, between one bank and another, comparatively little money has to pass. We tell you the story of Banks and Banking on page 5679. By the check system the actual use of money is almost entirely avoided. But remember—it is avoided only when a country's finances are running well. If we had bad paper money, we could not use checks, but should have to keep in our homes or offices, and carry about with us great piles of paper notes whose value would change from day to day.

GOOD MONEY—THE BASIS OF A HEALTHY INTERNATIONAL TRADE

Bad money in a country is an evil, not only for the nation which issues it, but for the world as a whole. That is true because, in the world today, a great deal of business is carried on between individuals and business firms in different countries. Thoughtful nations are trying to find ways of working together for the good of all. In the summer of 1944, at Bretton Woods, New Hampshire, experts in money affairs from forty-four nations met to talk over plans for co-operation. This was an important milestone in history. It marked the desire of intelligent nations to help themselves by understanding and helping each other.

By GRAEME O'GERAN.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 5679.

THE GAME OF BASKETBALL

BASKETBALL is one of the few sports of which we can say that it was invented in a certain year by a definite person for a definite purpose. James Naismith, an instructor at the Young Men's Christian Association Training School in Springfield, Massachusetts, created the game in 1891. He wished to develop a sport that could be played indoors in the winter time, when one could not play baseball or football or golf or tennis. Naismith called his new game basketball because the players tried to throw a ball into one or the other of two peach baskets set up at opposite ends of the playing court. The game soon became a favorite in schools, colleges and athletic clubs all over the United States.

The rules of the game have changed considerably since it was first introduced, but its principles remain the same. Modern basketball rivals baseball and football in popular appeal. Basketball has been introduced in some fifty other nations and territories and has won considerable favor wherever it has been played.

The court upon which basketball is played is not standardized as in the case of tennis, for example. The basketball court must not be less than 74 feet long nor more than 94 feet long; it must not be less than 42 feet wide nor more than 50 feet wide. Within these limits, however, courts of all possible dimensions have been laid out.

On page 5594 we give a diagram of a basketball court. The basket is set at a height of 10 feet from the floor. It consists of a black ring of metal, 18 inches in diameter; from the under edges of the ring is suspended a net of white cord. Behind each basket is a backboard, painted white; it is constructed of plate glass, steel or wood. Both the basket and the backboard are shown in the illustration on page 5596. There are two types of backboards; on page 5595 we show both of these types, also indicating the position of the basket with respect to the backboard.

Photo by J. M. Lewis

1. Getting ready for a free shot.

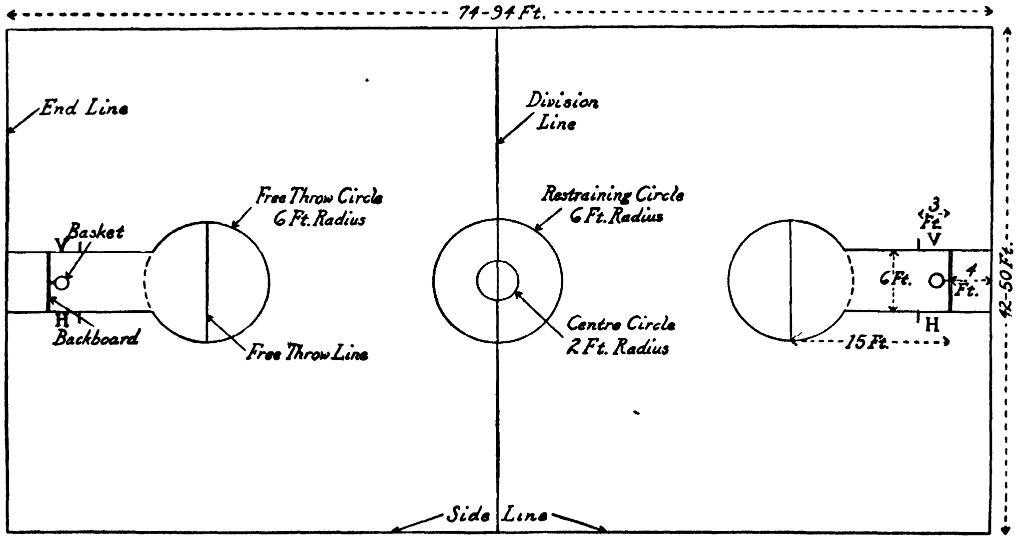
The basketball is a round inflated ball, from 29 to 30 inches in circumference. It consists of an airtight rubber bladder covered by an outer casing of leather. The basketball weighs from 20 to 22 ounces. Because of its round shape it can be passed more accurately than a football and its bounce is truer than that of a football.

There are six officials in a regulation basketball game—the referee, the umpire, two timers and two scorers. Each team selects one timer and one scorer. In modern basketball the referee generally covers one side and an end of the court, the umpire the other side and end; each of these officials is responsible for the calling of plays in the territory that is assigned to him. The referee decides matters on which the timers or scorers disagree and he also makes decisions on all points that are not covered by the rules.

Each team has five players—a centre, two forwards and two guards. To begin the game the referee goes to the centre of the court and tosses up the ball between the two centres. Each centre must stand with both feet on or inside the centre circle and must face his opponents' court; the rest of the players must stay outside the restraining circle (see figure 2). When the referee tosses the ball up, each centre waits until the ball has started to descend and then tries to tap the ball away from his opponent and in the direction of the opponent's court. This play is called either the centre tap or the jump ball.

After the jump ball each team tries to put the ball through the basket that is set in its opponents' court. The basket into which Team A is trying to toss the ball is called Team A's basket. This basket must be defended, of course, by Team B.

The players may bat the ball with their hands, pass it, roll it, bounce it or throw it in any direction; but they must not punch it, kick it or carry it. However, though a basketball player must not carry the ball, he may dribble it, that is, bounce the ball back and forth between either hand and the floor in such a manner that the dribbler keeps possession of the ball.



2. Diagram of the basketball court.

A number of fouls or illegal plays may occur in a basketball game; these fouls are called by the referee or umpire. There are two kinds of fouls—technical fouls and personal fouls. Generally speaking a technical foul is a violation of the rules that does not involve contact with one's opponent. For example a player commits a technical foul when he delays the game or insults an official. A personal foul is called when there is illegal contact with one's opponent. Personal fouls are charged when there is holding, pushing, charging, tripping or blocking. A player who has five personal fouls called against him is automatically forced out of the game and is not permitted to return to it. If a player is guilty of what seems to an official to be a deliberate violation of the rules, he is at once forced to leave the game; this is called a disqualifying foul. Sometimes both teams commit fouls at the same time; in this case we say that a double foul is charged. A multiple foul is committed when two fouls are called on a team on the same play.

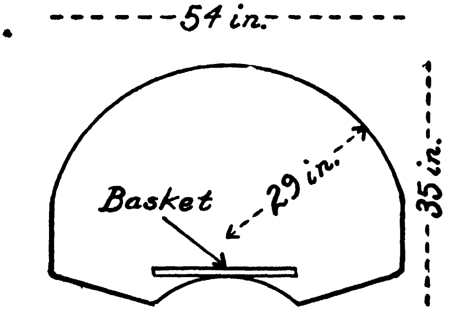
When any team has made a foul, the team which has been fouled is entitled to a free shot at its basket (remember that a team's basket is the one in which it is trying to put the ball). In the case of a personal foul, the person who has just been fouled takes the free shot at the basket. When a technical foul has been called against a given team, any member of the opposing team may make the try for goal. In the case of a multiple foul, the same player makes the try for both goals.

When a free throw is to be made, a player of the home team and a player of the visiting team, respectively, occupy the spaces marked H and V in the diagram in figure 2. The rest of the players on each team, or as many as so desire, line up beside H and V. An attempt is made to alternate the men of each squad on the line. On free throws for technical fouls the players do not line up along the free throw lane.

When a player gets the ball in the basket on a free shot, one point is added to his team's score. A goal made from the floor while the ball is still in play counts for two points; this is called a field goal.

After a field goal has been scored the ball is put in play again from behind the end line by a member of the team against which the goal was made. He must put the ball in play within 5 seconds after getting his hands on the ball. After a free throw the ball is played to the court from the end line by any opponent of the free thrower, if the throw has been for a personal foul and has been successful. If the throw has been for a personal foul and has been unsuccessful, the ball continues in play. Following a throw for a technical foul, whether or not the throw is successful, the ball is put in play from out of bounds at mid-court by any opponent of the free thrower's team.

In the course of a fast basketball game the basketball is often sent out of bounds as a result of a player's batting the ball or bouncing it or throwing it. In that case the referee stops play by blowing his whistle. He then gives the ball to an opponent of the player who had sent the ball out of bounds and the ball is put into play again from out of bounds. If the official cannot decide who last touched the ball, the ball is put into play by a jump ball near the spot where the ball left the court but at least 6 feet from the side boundary line.



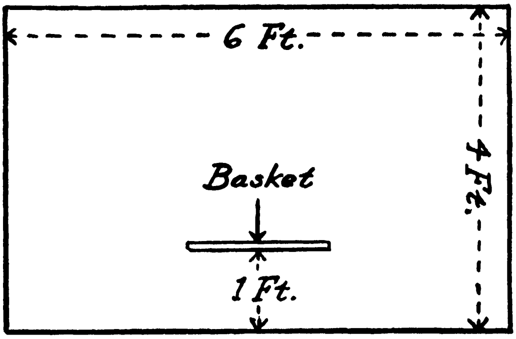
3. Fan-shaped backboard.

Sometimes it happens that two players, of opposing sides, will grasp the ball at the same time in such a manner that neither player can get free possession of the ball. In that case a held ball is called and a jump ball takes place at the spot where the ball was held. If a held ball is declared in a free throw lane, the ball is tossed up at the free throw line. If a held ball is called inside the restraining circle, it is tossed up from the centre circle. A held ball that is less than 6 feet from a boundary line must be followed by a jump ball at a distance of 6 feet from the boundary line in question.

A team in possession of the ball in its own court must bring it back to the centre line within 10 seconds. This is to prevent a team from delaying play by passing the ball to and fro in its own court.

In the case of college teams, there are two 20-minute periods or halves with an intermission of 15 minutes between halves. Sometimes, by mutual agreement between the two teams, there are four 10-minute periods or quarters; there is a 2-minute intermission between the first and second quarters and the third and fourth quarters and a 10-minute intermission between halves.

In high school games there are four 8-minute quarters, with a 2-minute intermission between the first and second quarters and the third and fourth quarters and a 10-minute intermission between halves. For boys 14 years of age or younger there are generally four 6-minute quarters, with a 2-minute intermission between the first and second quarters and the third and fourth quarters and a 10-minute intermission between halves.



4. Rectangular backboard.

The captain of each team is entitled to take a time-out for his team at any time. If the time-out lasts more than one minute and less than two minutes, two times-out are called; if the time-out lasts more than two minutes and less than three minutes, three times-out are called, and so on. Each team is allowed five times-out in the course of a game. A technical foul is called for each additional time out.

If the score is tied at the end of the second half in the college game, play is continued for an extra period of 5 minutes or for as many 5-minute periods as may be required to break the tie. There is a 2-minute intermission before each extra period.

If the score is tied at the end of the fourth quarter in games between high school or junior players, there is an intermission of 2 minutes; then there is an extra period of 3 minutes. If the score is still tied at the end of this 3-minute period, play is resumed after a 2-minute intermission. The first team to score 2 points in this second extra period wins the game. The second extra period cannot last more than three minutes. After that time, if neither team has scored 2 points or if both teams score their second goal of the period at the same time as the result of a double foul, play is suspended again. If one team has scored 1 point in the second extra period and the other team has not scored, the first team wins. If the score is still tied, there is an intermission of 2 minutes. Then the players begin to play a third extra period, under the same conditions as the second. As many extra periods, with 2-minute intermissions, are played as are necessary to break the tie.

Formerly scoring was confined largely to the two forwards and the centre while the guards were used chiefly on the defense. Nowadays each team generally acts as a unit while attacking in the other team's territory; the guards have many shots at the basket and often score many points.

The women's basketball game is like the men's game in most respects. Following are the chief differences: The official size of the court is 90 feet by 45 feet. The centre circle has a radius of 3 feet, instead of 2 feet, as is the case in men's play. There are six players on each side—three forwards and three guards. Any one of the forwards may tap the ball in the jump ball that starts the game. There are four quarters of not more than 8 minutes each, with an intermission of 2 minutes between the first and second quarters and the third and fourth quarters and a 10-minute intermission between halves. If the game is tied at the end of the fourth quarter, the score stands; there are no extra periods in women's basketball.

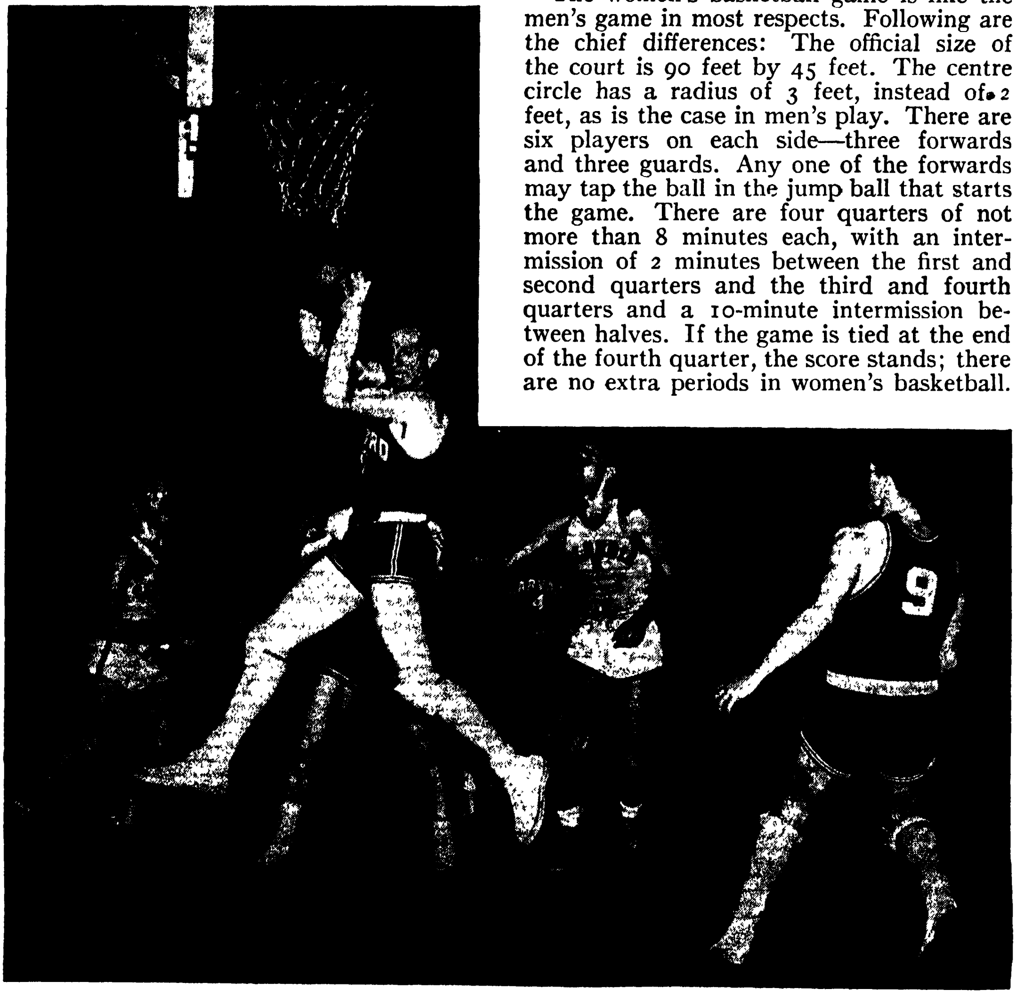


Photo by J. M. Lewis

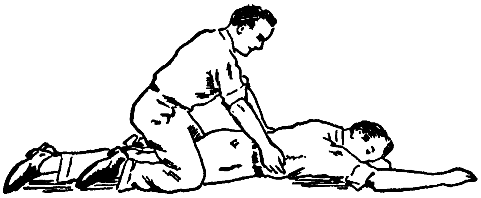
1. Getting the ball off the backboard after an unsuccessful shot at the basket.

FIRST AID TO THE INJURED: LESSON V

HOW TO APPLY ARTIFICIAL RESPIRATION

EVERY boy and girl who reads these articles on first aid should know how to apply artificial respiration (drawing in and letting out of the breath) to a drowning person who has stopped breathing. In artificial respiration, by means of skillfully applied pressure on the patient's body, we help him to breathe until he starts breathing normally again.

There are a number of ways of applying artificial respiration; but it would be well to learn just one method and to know it thoroughly. The one that is perhaps most popular at the present time is the Schäfer or prone-pressure method (so called because the patient lies prone or face downward while the pressure is being applied). This method is recommended by the American Red Cross, the United States Public Health Service and other organizations.

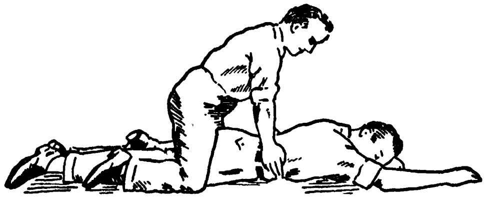


1.

Artificial respiration should be applied as soon as possible after the accident occurs. Do not move the patient too far from the scene of the accident, but begin the treatment at the first possible moment. Delay may prove fatal.

In the prone-pressure method, as we have said, the patient is laid face downward on the ground. The head is placed "down hill" on a 10 to 15 per cent slope. One arm of the patient is extended straight ahead and the other is bent at the elbow. The face is turned outward so that one side of it rests on the hand or forearm; this leaves the nose and mouth free for breathing (see figure 1). The operator (the person applying this first aid treatment) kneels astride the patient, facing the patient's head. The operator's knees touch the ground just behind the patient's hip bones and the palms of the operator's hands are placed on the small of the patient's back, one on each side, as illustrated in figure 1.

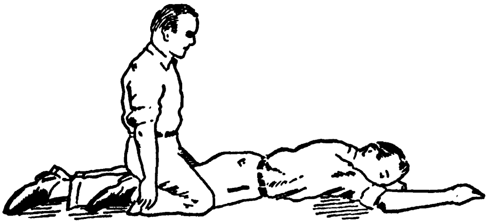
With his arms held straight, the operator now swings forward slowly so that the weight of the body is gradually brought to bear upon the patient. The operator's shoulder should be exactly over his hand at the end of the forward swing (see figure 2). The elbows should not be bent. In this operation, which should not take more than two seconds, the air and water are driven out of the patient's lungs.



2.

The operator now swings backward, rising slowly so as to remove the pressure completely (see figure 3). After two seconds he swings forward again. The double movement of pressing and letting go makes a complete respiration in four or five seconds. The double movement is repeated twelve to fifteen times a minute. The treatment should be continued for several hours if necessary, until normal breathing is restored or until a physician pronounces the patient dead.

If possible, while artificial respiration is carried out, an assistant should loosen any tight clothing about the patient's neck, chest or waist. The patient should be kept as warm as possible; the assistant should apply



3.

hot flannels or, if available, hot water bottles wrapped in towels to the limbs.

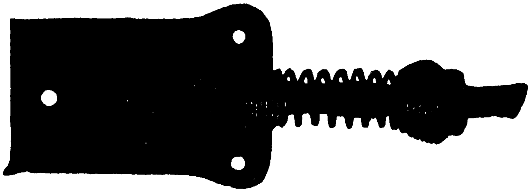
Continue to apply artificial respiration for at least several minutes after the first return of natural breathing. Then stop, but watch the patient carefully and be ready to continue the treatment if necessary.

To avoid strain on the heart when the patient revives, he should not be allowed to stand or even to sit up but he should be kept lying down. He should be wrapped in dry blankets or coats. The limbs should be rubbed briskly, to restore the circulation of the blood. If the doctor has not arrived by the time the patient revives, the latter should be given a stimulant—hot coffee or tea or a teaspoonful of aromatic spirits of ammonia in a small glass of water.

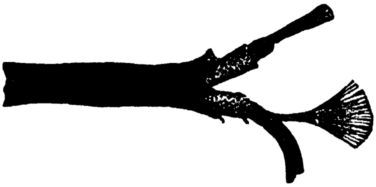
Article prepared with the assistance of the Metropolitan Life Insurance Company.

HOW TO REPAIR AN EXTENSION CORD

THE insulation of an extension cord, like that used on electric toasters, is sometimes worn away at the place where the cord enters the attachment. It is easy to repair the cord in a case of this kind. First disconnect the cord from the house current. Then remove the cover from the attachment, as shown in the first picture, in order to remove the wires from the binding posts. Next loosen the screws on the binding posts so as to release the ends of the cord. Cut off the damaged part of the cord. Cut away the cotton binding for a distance of an inch or so and scrape away the rubber insulation at the new ends. (See second picture.) Fasten the ends under the binding posts as you found them, being certain that the wire is held well. Put together the attachment again, and then try it out by turning on the current.



Attachment with cover removed.



Ends of extension cord.

PROVERB GAMES

A NUMBER of interesting games can be played with proverbs. These games will provide a good deal of fun at parties, when a number of friends have gathered together.

CALLING PROVERBS

THE game of Calling Proverbs is played in the following way: One player retires from the room. The others choose some proverb and each takes one word of the sentence. Then the player who has left the room comes back; at a given signal all the others call out their words at the same time. From these mixed sounds the player who has just come in has to try to guess the proverb that has been selected. If he does not guess it at first, the proverb is shouted again and again until he does guess it or until he gives up in despair. This is a very noisy game, but it provides a good deal of amusement for all the boys and girls present.

ACTING PROVERBS

IN this game each player becomes the actor in turn. He has to act out a proverb by giving the appropriate gestures. The other players watch him and try to guess what the proverb is. For example, if the actor goes through the motions of sewing, the proverb in question is "A stitch in time saves nine." If he rolls a pebble along the ground and then, picking it up, looks eagerly for something on its surface, we know that he has in mind the proverb "A rolling stone gathers no moss." There is no end to the proverbs that an ingenious actor can present in this way, by acting them out.

WRITING PROVERBS

THERE are several proverb games that can be played with pencil and paper. For example, each player writes upon a piece of paper a proverb from which every second letter has been omitted. Thus the proverb "Birds of a feather flock together" would be written thus: "Brsffahrlctgte." The letters are all run together to make the puzzle more difficult. Then the papers are exchanged and each player tries to decipher the proverb that has been given him.

Another good way to disguise a proverb is to abbreviate some of the words in it in such a way that each abbreviation represents a word in itself. For example for "Well begun is half done" we might have "We gun do."

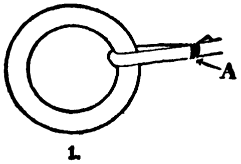
In all these games remember that the proverbs chosen should be really popular ones that all the people present should know. You will find that there are a great many of these proverbs to choose from.

A COLORFUL BELT

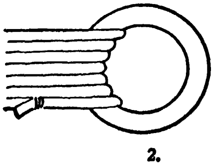
THIS belt of crepe paper is unusually attractive in leaf green and brown, but of course you may use other combinations of colors, if you wish.

First make a rope by twisting and stretching strips of green crepe paper 4 inches wide. It is easy to do this with two people working together. One end of the crepe paper is tied to a pencil. Then one person holds the free end of the paper firmly; the other person stretches the crepe and then twists it by means of the pencil until a tight strand is formed. Each end of this strand is now fastened temporarily to some firm object so that the strand will not unwind. Two other strands are made in the same way. Then the three strands are twisted together in the opposite direction from that in which they were originally twisted. Do not be afraid to pull hard or to twist as tightly as possible. Keep pulling to take out any kinks and to make the strand perfectly smooth and tight. You will now have a tough rope made up of three strands. Paste these three strands together at the ends in order to keep your rope from raveling.

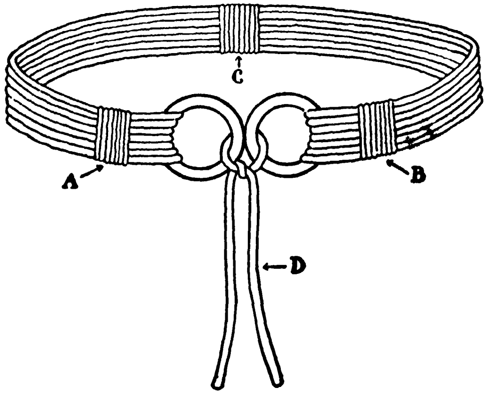
Next provide yourself with two wooden drapery rings; if they have small screw eyes in them, these should be removed. Pass one end of the rope through one of these rings and fasten it one inch from the ring (at A in figure 1) with spool wire. Pass the rope through the other ring at a distance of 24 inches (more or less according to your own waist measurement) from the first ring. Keep looping the rope back and forth through the rings until there are seven strands. Pull the belt out to be sure that all strands are even. Then fasten the end in place with wire (as shown in figure 2) and cut off the surplus rope.



1.



2.



3.

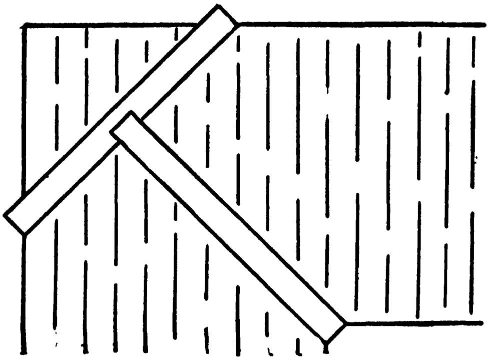
Now weave spool wire in and out between the ropes near the rings and at the centre of the back (at A, B and C in figure 3). Cut strips of brown crepe paper, one inch wide, across the grain and twist between the fingers into a tight strand. Wrap this strand around the belt for one inch to cover the wire fastenings at the front and at the centre of the back (A, B and C in figure 3). Paste the ends in place. Thread a brown crepe strand on a large tapestry needle. Then take a number of stitches through the wrappings at A, B and C in figure 3, making the stitches run horizontally with the belt and between the crepe ropes.

Finish with a piece of crepe rope (D in figure 3), slipped through the rings and knotted once in front. Fasten the ends of the crepe rope with paste in order to keep it from raveling.

ANSWER TO THE PROBLEM ON PAGE 5336

THE natural thing for the farmer to do was to try to place his planks across the ditch at its narrowest point. This narrowest point, however, was not less than 10 feet wide, and as each plank was only 10 feet long it was of course impossible for him to span the bridge in this way. He was also forbidden to nail the two planks together.

However, he solved the problem in a very ingenious way. He placed one bridge across a corner of the moat in the manner shown in the illustration. Then he placed the other plank in such a way that one end rested on a corner of the island and the other end upon the plank that he had just laid down. By arranging the two planks in this manner, he succeeded in crossing the ditch with ease.



SOME EXERCISES TO PRACTICE AT HOME

SOME boys and girls find it difficult to keep a correct posture. When somebody tells them to straighten up, they do so, but only for a few minutes. Then the head sinks again, the shoulders come forward and the back becomes round again. The best way to acquire correct posture is to take daily exercises that will strengthen the muscles and make correct posture a perfectly natural thing. Here are some simple exercises that you will find useful for this purpose.

BREATHING (I)

(1) Place first finger of left hand on left nostril, so as to close it. (2) Breathe in deeply through right nostril. (3) Remove finger from left nostril and close right nostril with right forefinger. (4) Breathe out slowly from left nostril. (5) Repeat, this time breathing in through the left nostril and out through the right.

BREATHING (II)

(1) Start with the arms at the side, palms turned inward. (2) Breathe in and press the shoulders back,. at the same time gradually turning the palms outward. (3) Breathe out and return to the first position.

ARM EXERCISES

(1) Arms upward bend; extend arms upward to their full reach, keeping the palms facing inward. (2) Arms forward stretch; keep arms and hands the width of the shoulders apart, palms facing, arms level with the shoulders, body upright. (3) Return to arms upward bend. (4) Arms downward stretch; arms held straight downward, palms turned to sides, fingers straight, shoulders well back. (5) Arms upward bend.

FOOT EXERCISES

(1) Stand straight, feet together, toes pointing slightly outward. (2) Place left foot forward two foot-lengths in direction to which toe is pointing; bend knee of left leg slightly, and keeping the right straight, divide the weight of the body equally between the two legs. (3) Return to first position. (4) Repeat movement described in (2), this time with right foot. (5) Return to first position.

TRUNK EXERCISES

Be careful to breathe naturally all the time that you are doing these exercises; do not hold the breath. (1) Stand straight, with feet together, hands on hips. (2) Raise the chest and bend the upper part of the spine slightly backward, the head being carried back with the body. (3) Return to first position. (4) Turn trunk to left, keeping body straight and moving head with body. (5) Return again to first position. (6) Turn trunk to right. (7) Return to first position.

Each one of these exercises should be repeated a number of times. You might begin by doing each series ten times. Then you can increase the number as you find it easier to do the exercises. You might set yourself a limit of twenty-five times.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 5763.

FLOWERS OF ROCKY PLACES

MANY boys and girls are fortunate enough to live at the foot of some mountain. Some may even dwell in lonely farmhouses upon the slopes. These children have a splendid opportunity to study wild flowers, for not only do the mountains provide many kinds such as we cannot find growing wild anywhere in the lowlands, but many of the lowland plants will also grow on the mountainside. Some of the lowland plants will not grow at a greater height than a thousand feet above sea-level; and some mountain plants will not grow upon soil less than two thousand feet high, and so on. On the other hand, we may find certain lowland plants growing at various heights.

The term "plants of rocky places" generally means, in America, those of hilly or mountainous country, as our beaches are chiefly sandy. They have no particular character, such as the fleshiness of maritime plants, except in the case of those growing upon the tops of high mountains. In such a position extremes of heat and cold have to be combated, drought is frequent, snow is often present near by, and the winds are terrific. Consequently only those plants that, through the ages, have adapted themselves to these conditions, survive. One finds that usually these "alpine" plants (as those which grow on mountain-tops above timber-line are called, whether in the Swiss Alps or not) are peculiarly dwarfed, spreading, mat-like, in squat, tufted masses, but with brilliant flowers larger than the size of the plant would seem to call for. This compact form, combined with masses of bloom and a certain resistance to drought and to heat and cold, has made the alpine vegetation welcome to the gardener, who plants them on the tiny hillocks he erects in his rockery, and finds that they continue to thrive and bloom.

The low stature of the plants and their close-set branches are, of course, the best form with which to resist the winds and meet their other trials. A tall plant would soon be blown off, and the trees and shrubs, as well as the herbs found high on mountains, are so dwarfed, twisted and contracted as to seem quite unrelated to others of their kind growing at the base. As for their brilliantly hued, large flowers, it is said that "on the heights above the tree-line there is actually no spring and no autumn, only a short summer following a long winter. All the flowers have therefore to blossom in this short time, and all the flower-visiting insects must do their flying about during the short period which is free from snow, if they do not wish to starve." Therefore, as soon as the snow is melted the flowers appear in every color, alluring the bees, butterflies and flies that depend upon their honey and pollen. By these means the insects are satisfied, and in one way or another they transfer pollen from the anthers of one flower to the pistil of another of the same kind.

There is one family which contains many of these alpine plants—the Saxifrage Family, the name meaning "stonebreaker" and given because the varieties so often spring out of cracks and pockets in cliffs, quite as if they had split the hard rocks to make room for themselves. But some of them, although growing on mountains of the Old World, belong to less elevated places in the New, especially in northern Canada, where they may be found far up in the arctic regions, where the climate is much like that of mountain peaks. Thence they sometimes follow the great cool-topped mountain ranges into the United States, but, generally speaking, rarely occur south of Canada.

MOUNTAIN SAXIFRAGE GROWS NEAR MOUNTAIN RILLS

One such southward-growing species is the Yellow, or Mountain, Saxifrage, that is found about the rock-rills that come down the mountainsides, where its narrow, oblong leaves form large green cushions a foot across. The flowering stems stand well above the cushions and bear a number of scattered flowers, whose yellow petals are dotted with red. The petals stand wide apart and the space is partly filled by the green sepals, upon each of which lies a golden stamen.

AN ORPINE WHICH HAS A ROSE-SCENTED ROOT

Another northern plant that is frequently cultivated is the Rose-root, which is very closely allied to the saxifrages, but is included in that curious family of fleshy plants the Orpines, which can flourish in the most unlikely dry and barren places, and which include the live-forever and the stonecrop. This one, however, unlike most of its family, likes rocks dripping with moisture, and produces thick, fleshy stems and thick, gray-green leaves that are flat, nearly round, and more than one inch across. Its little waxy flowers are grouped in massive heads varying from yellow to purple in tint. Its branching rootstock, when broken, exhales an odor of roses.

THE PINK OR PURPLE FLOWERS OF THE MOSS-CAMPION

A low habit like that of the saxifrages is to be noticed in several of the Pink Family when rooted upon rocks. One of these is the Moss-campion, a plant that is only an inch or two high, with slender awl-shaped leaves. The stems grow in dense spreading tufts that look much like a growth of bright green moss into which somebody has stuck a number of pink or pale purple flowers.

These flowers have no visible stalks, and although they are only half an inch across, they look so big in proportion to the leaves that they appear to have been plucked from some larger plant and set among moss. They are of similar structure to the red campion and white campion of lowland fields and hedgerows. It grows in arctic America and on the summits of mountains as far south as Arizona.

MOUNTAIN SORREL AND THE ALPINE MEADOW-RUE

This herb we shall not fail to recognize as one of the relatives of the common sorrel of lowland fields, although its kidney-shaped leaves differ so much from the common kind. Its spray of flowers, however, allows us to make no mistake. Closely examined, they will be found to have only four sepals, while other sorrels and docks have six. It is not unlikely to be accompanied by the alpine Meadow-rue, whose small leaves, with rounded leaflets in sets of three, are gathered into tufts. This herb does not look very much like the buttercups, to whose family it nevertheless belongs, but closely resembles our other meadow-rues in its tossing tassels of stamens.

THE COLUMBINE PROVIDES THE HUMMING-BIRD WITH FOOD

Neither would the Columbine suggest a buttercup, although a member of the latter's family, as it flaunts its jewel-like gold and scarlet flowers on rocky hillsides. Fitted, as they are, on slender stems that are thrust out from tiny clefts in a rock-face, the columbines tremble in every whiff of wind, and send their yellow pollen flying, to alight on the outstanding pistils of other columbines. Nor are they neglected by insects, though only those with long tongues can reach up into the

The Mossy Saxifrage

This is a wild flower of the Irish mountains that is frequently grown in our gardens. It is picturesque, with erect shoots bearing white flowers, and is useful in a rock garden. The leaves are in lobes.

The Yellow Mountain Saxifrage

This is another of the Saxifrages. It grows on wet rocks from Newfoundland and Labrador to Vermont and western New York. In arctic America it grows as far west as the Rocky Mountains.

The Common London Pride

This plant is called London Pride because it thrives even in London, where soft-coal smoke ruins plant life. It is one of the saxifrages and grows in gardens in Canada and the United States.

The Moss-campion

This densely tufted mossy plant, with the pink and white flowers and the awl-shaped leaves, is found growing only on the summits of higher mountains. It grows in the White Mountains and in the west.

The Bilberry

The Bilberry is a plant of many names, whortleberry, whinberry and myrtleberry being most familiar. The leaves are egg-shaped, and the flowers flesh-colored and wax-like. Found on hills.

The Clethra

Clethra can be easily found in swampy lands of the Atlantic coast by the rich, far-flung odor of its waxy flowers, projecting like spearheads from bushes among alders, which these shrubs resemble.

The Wild Gooseberry

The American Wild Gooseberry flourishes in rocky woods, rooted in the clefts of cliffs and ledges. Its berries look like those of the garden bush, but are considerably smaller and more tart to the taste.

The Flowering Raspberry

This gaudy bush shows itself a kind of raspberry, but its flowers alone might deceive one into thinking it a wild rose, to which family it belongs. Its fruit is pretty and it blooms late in summer.

The Alpine Meadow-rue

This graceful little plant, with its purple flowers, is found principally upon the mountains of Wales and Scotland, and grows about six or eight inches high. It is unlike the family to which it belongs.

The Mountain Sorrel.

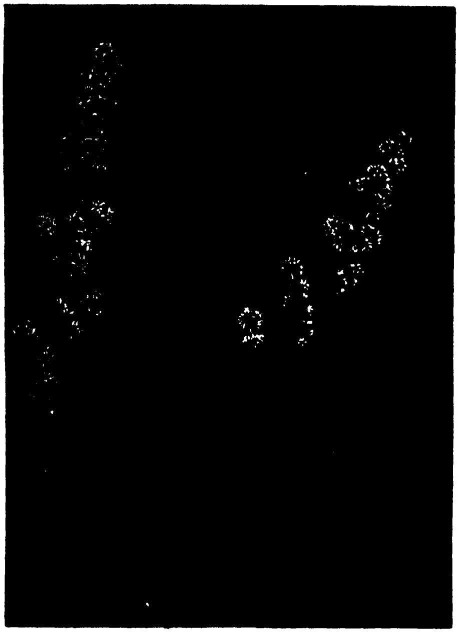
This plant resembles the common sorrel of our meadows, but is shorter and stouter. The leaves grow on long stalks, and the green flowers are in clustered spikes. It grows in damp places on hills

The Glaucous Honeysuckle

This honeysuckle is a midsummer bloomer which stands upright, holding in its thick double leaves, as in a bouquet-holder, clusters of honey-colored flowers like those of the garden honeysuckle.

The Rose-root

The Rose-root is found only in the mountainous districts of the north and arctic regions. It is a relative of the stonecrop. The yellow flowers grow in a dense mass at the tops of the erect stems.

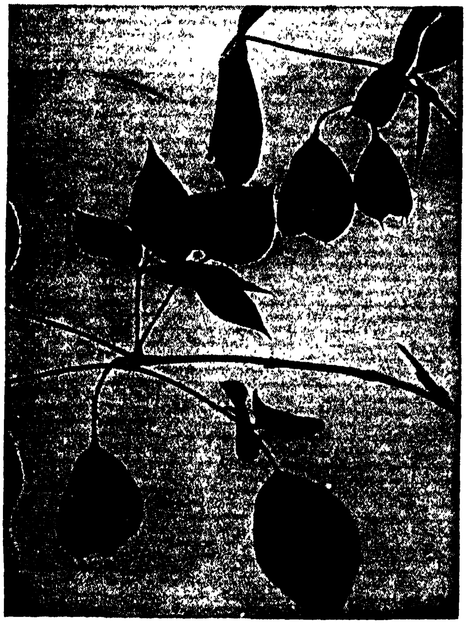


The Wild Spikenard

The Wild Spikenard is one of the loveliest plants of our woods, its white, starry little flowers gleaming in the green shadows. In autumn the flowers give place to the scarlet berries of the thickets.

The European Globe Flower

The European Globe Flower, of the Buttercup Family is so called because its pale yellow flowers grow in a globe form. The American Globe Flower is single, with five petals.



The Bladdernut

These are the quaint pouch-like fruits which give its name to the Bladdernut—a shrub which in spring shows us white flowers. The leaflets are in threes. They are mostly small trees, but pretty.

The Pink Lady's Slipper

Velvety Pink Lady's Slippers nod over sandy forest floors in early spring. The Greek name, Cypripedium (or Venus' buskin), and the Indian one, Moccasin-flower, both refer to the "lip."

The Ninebark

The Ninebark has long drooping branches, often swaying down to the grass, in midsummer loaded with ball-like clusters of lovely little white and pink blossoms. It belongs to the Rose Family.

The Balsam

The Balsam, or Jewel-weed, grows in mountain swamps. Its golden flowers quiver on slender stalks; the ripe seed-vessels open at the slightest touch, ejecting the seeds, whence "touch-me-not."

The Sea-pink

The Sea-pink or Thrift, is found on seashores and the tops of mountains. The fleshy leaves grow in dense tufts, and the rose-colored flowers in clusters at the ends of the stalks. In Latin it is Armeria.

The Common Scurvy-grass

The Scurvy-grass is not a grass at all, but is a member of the Cabbage Family. It is a small plant with white flowers, and grows usually on muddy seashores in the north, and also on lofty mountains.

tips of the horns, where the honey-drops are. Humming-birds stab flower after flower, thrusting them back against the rock with their rapid assaults as they swiftly probe each spur. In the American species the horn-like spurs of the petals are not so strong and hooked as those of Europe, whose size gave rise to the quaint notion that they resembled the necks of doves billing across the stem; whence the name columbine from the Latin word *columba*, which means "dove." Its generic name is *Aquilegia*.

THE BILBERRY OF THE NORTHERN MOUNTAIN RANGES

High on the northern mountain ranges of both hemispheres we find the great Bilberry, a thick-leaved little shrub with blue-black bloom-covered berries that the Scotch call bleaberry. It belongs to the Huckleberry Family, is a near relative of our huckleberries and of the European whortleberry or myrtleberry, and looks very much like them.

Its nearly closed, waxy, white or pinkish bells bend stiffly downward, and when a bee clings to the flowers' opening, and pushes its tongue in to reach the nectar, its head is almost certain to push against the tails of the anthers; and the act, by tilting the tube of the anther and springing the tip, in which there is a chink, away from the pistil, allows a shower of pollen to fall upon the bee's face. We can see from the position of the pistil that when the bee visits the next flower, this pollen will be scraped off upon the stigma.

THE PALE GREEN PRICKLY FRUIT OF THE WILD GOOSEBERRY

There is one little bush, easily recognized, for it closely resembles the cultivated gooseberry, and, in fact, is merely a wild species of gooseberry. It is apt to grow in shady woods, in pockets of the rocks, and often the slender branches, bent down by the weight of the pale green spiked berries, droop from the ledges of high cliffs. It furnishes a tart, wild fruit for sweetmeats, more highly flavored than the tamer kinds, but, in some species, more generous as to prickles, although these are somewhat softened by cooking.

THE FLOWERING RASPBERRY, WITH BRIGHT FLOWERS AND FRUITS

Near the gooseberry, but on sunnier ledges, grows another scraggly, brittle-stemmed bush, bearing fruit quickly identified as raspberries—but very dry and unpalatable raspberries. The whole shrub is furry in appearance. The great maple-like leaves are softly green, and the crumpled magenta-colored petals emerge from a collection of hairy sepals and stems. Even the bright scarlet flattish fruits are fuzzy. This is known as the Flowering Raspberry, and it blooms profusely during late summer, the flowers resembling those wild roses in whose family the shrub is placed.

FLOWERS OF THE HONEYSUCKLE FAMILY, BELOVED BY INSECTS

Several members of the tribe of honeysuckles, both upright shrubs and trailing vines, display themselves on our rough hillsides. One of the earliest plants to bloom is the Fly-honeysuckle, with its pale yellow twin flowers. Much later comes the half-climbing, half-upright Glaucous Honeysuckle, with its close branches of honey-colored, green and purple-tinged flowers, very like those of the cultivated honeysuckles, but half hidden by the wide flaring cup formed beneath them by the union of the uppermost pair of leaves on the stalk.

On dry and rocky ledges, especially common on the islets of the St. Lawrence River, blooms the Bush-honeysuckle, or Diervilla, which has long-pointed opposite leaves and yellow flowers very attractive to bees and other winged insects.

BLACKBERRIES LIKE TO GROW IN ROCKY, MARSHY PLACES

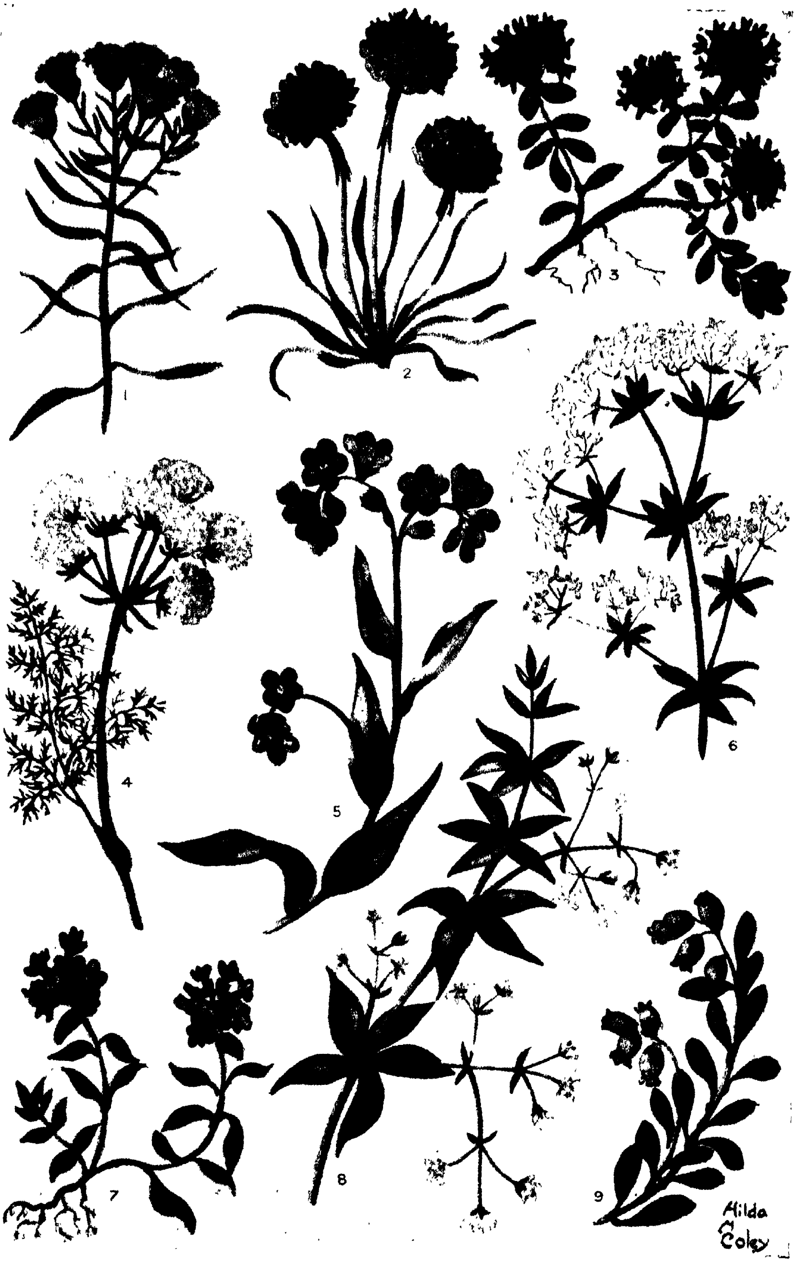
Some blackberries have adjusted themselves to life in hot sands, and creep valiantly under a blazing sun, bearing large white five-petaled flowers like single roses, and later the succulent pulpy fruit that we call dewberries. But the tall blackberries prefer rocky, marshy soil where they can find water to swell their long luscious berries, not fully ripe until the birds begin to steal them. Brandy or cordial made from these berries is used in medicines.

THE CREAMY CLETHRA FLOWERS GIVE HONEY TO THE BEES

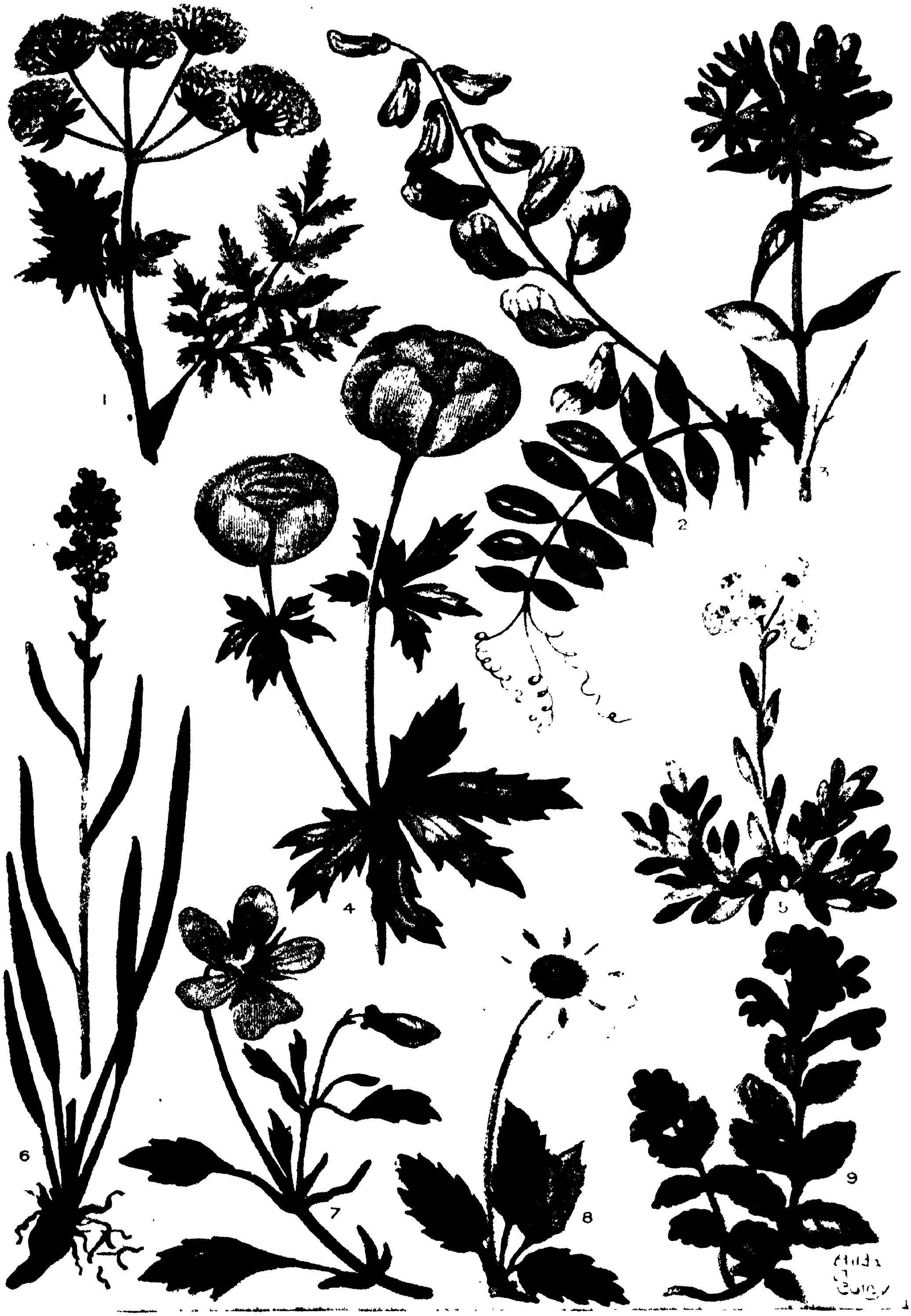
The Clethra shrub is sometimes known as a sweet pepper bush or white alder. Although it grows generally among the ordinary alders at the edge of swamp or stream, one species inhabits mountains. The foliage is not unlike that of ordinary alders, but it is the long spikes of creamy-tinted, waxy, thick-petaled little flowers, heavily perfumed and yielding honey for bees, which render the clethra interesting.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 5727.

FLOWERS OF ROCKY PLACES

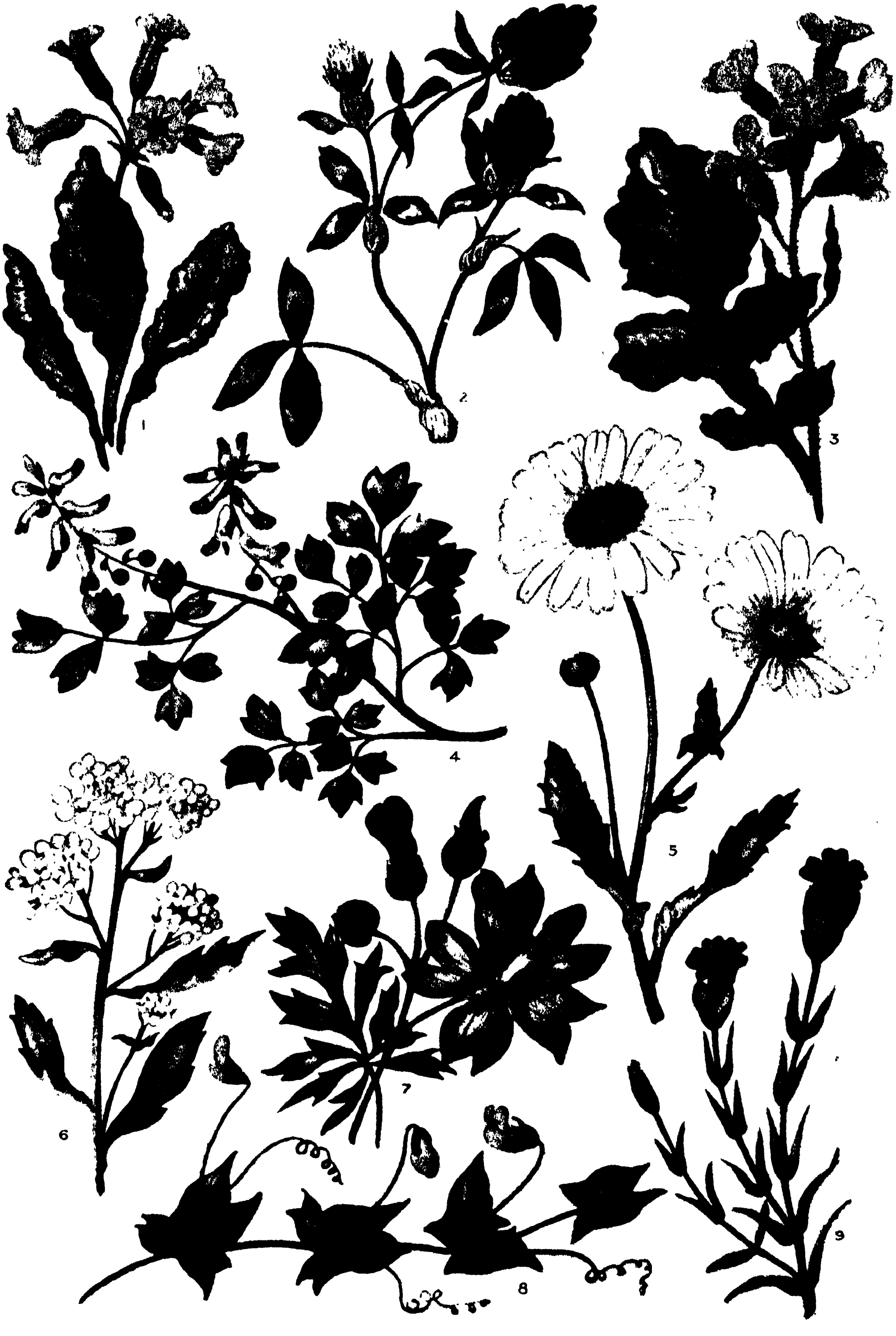


1. Goldilocks. 2. Thrift. 3. Trailing Daphne. 4. Spicknel. 5. Mountain Forget-me-not. 6. Mountain Bedstraw. 7. Mountain Thyme. 8. Bedstraw. 9. Bearberry.

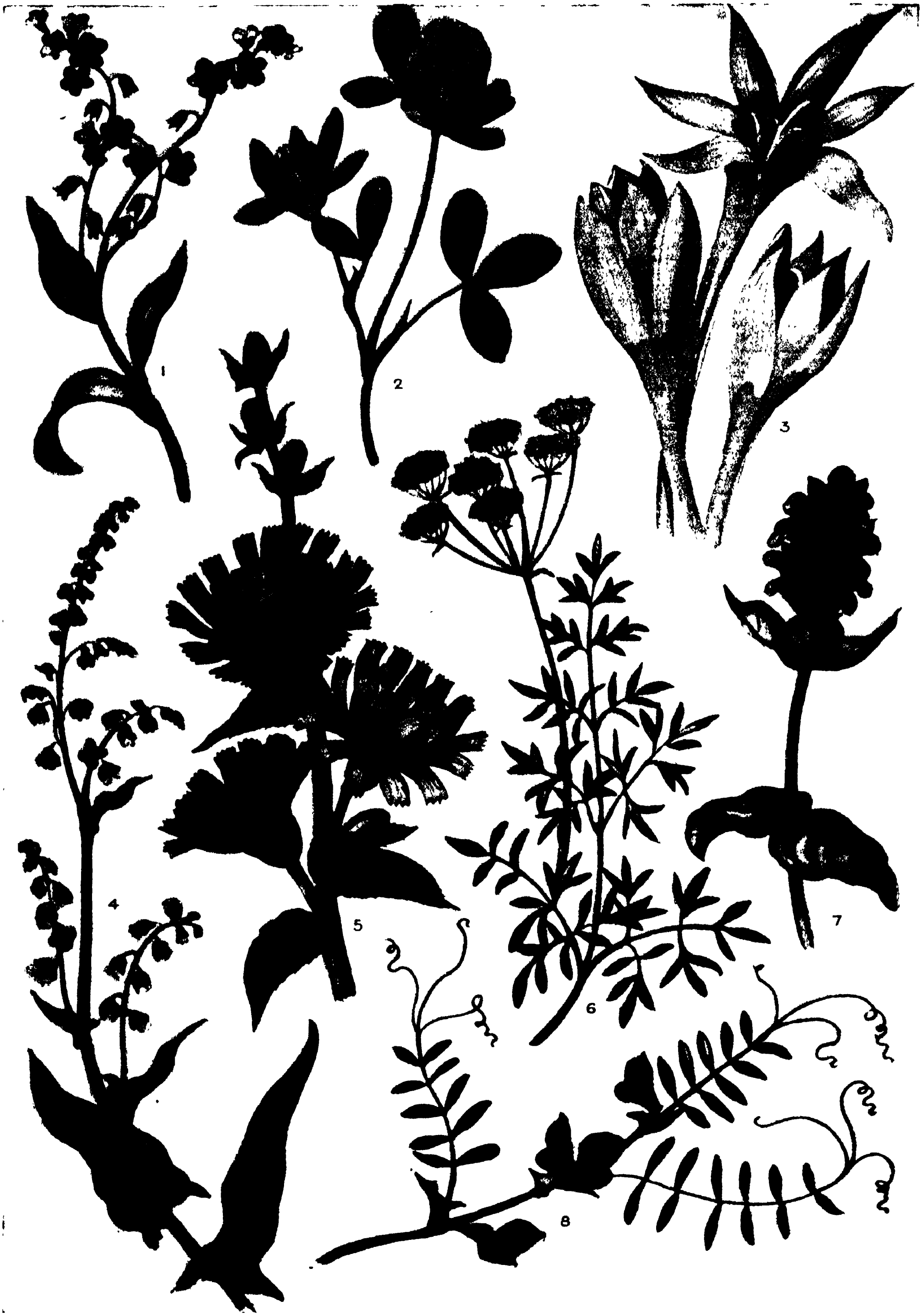


1. Sweet Cicely. 2. Wood Vetch. 3. Red Alpine Campion. 4. Globe-flower (E.). 5. Pussy Toes. 6. Alpine Bistort. 7. Yellow Pansy. 8. Mountain Avens. 9. Alpine Bartsia.

Flowers marked (E.) are European and are not generally found in America.



1. Cowslip (E.). 2. Red Clover. 3. Wild Radish 4. Common Fumitory. 5. White Daisy. 6. Candytuft (E.). 7. Musk Mallow. 8. Yellow Vetchling. 9. Proliferous, or Childing, Pink



1. Forget-me-not. 2. Yellow Hop Clover. 3. Meadow Saffron (E.). 4. Garden Sorrel. 5. Chicory. 6. Pepper Saxifrage (E.). 7. Self-heal. 8. Slender Vetch.

Why Are We Like Our Parents?

THE Bible, which calls the descendants of Abraham the "seed of Abraham," furnishes the best and shortest answer to the question, Why are we like our parents? In it we read that God said: "Let the Earth bring forth the living creature *after his kind*"—a statement of the law that offspring shall be like their parents.

We shall examine that kind of living thing from which we get the idea of seed, the living plant or flower. Before a flower will produce seed it has to be fertilized, or sprinkled with pollen. Pollen is made up of very tiny grains, which we may call the male germs of life.

Deep down in the flower is another tiny structure, which we may call the female germ of life, and it can be compared to an egg. When the grain of pollen reaches this very simple egg it mixes with it. The result of this mingling of the male and female germs is that the egg grows, and in course of time it produces seed.

Keystone View Company

Both father and mother of this family have the straight black hair and narrow slanted eyes of Chinese people; and every child has the same type of eyes and straight black hair.

In this seed are all the mysterious possibilities and powers of life. The seed is really the resting stage of a young plant, and when it is sown and fed by the soil it grows into a plant, which in its turn produces flowers, and the whole process of reproduction is repeated from generation to generation.

Exactly the same is true of numerous other creatures, men and women among them. Two tiny germs of life, one male and one female, unite to form a single cell. This divides and subdivides in a marvelously intricate, yet orderly, way, becoming the child, which ultimately grows up into the man or woman, resembling the parents, yet having traits of its own. A portion of this new individual, namely the germ-cells, is again set aside to carry on the race.

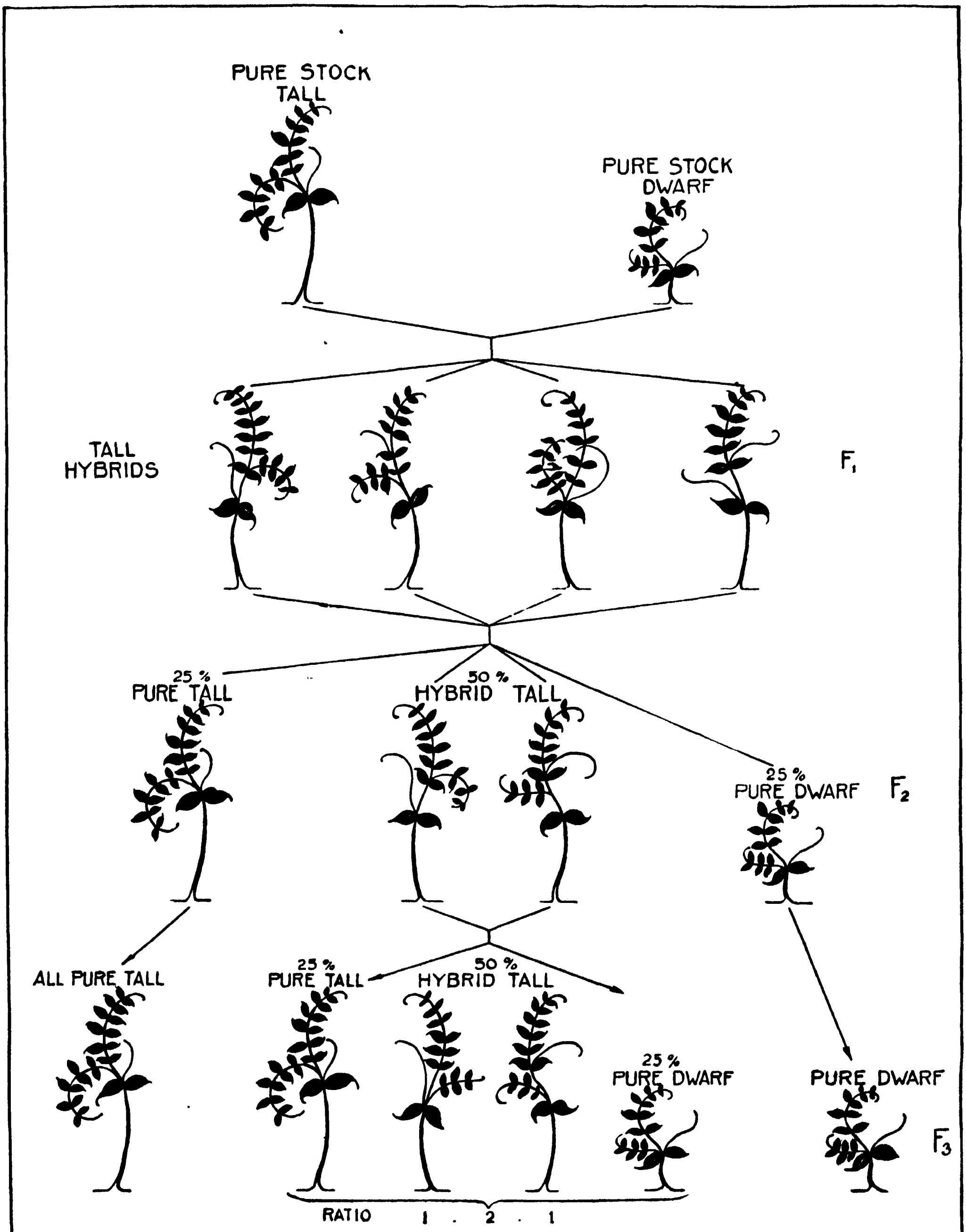
Except for the influence of the home, which in many ways makes us like our parents, the generations are tied together only by the slender thread of the germ-cells. Into these tiny specks of protoplasm is packed the whole complicated machinery of heredity.

Through all the ages men have wondered about the mysteries of heredity, but it was only toward the end of the last century that a beginning was made in understanding them. The modern science of heredity—called genetics (from the Greek-Latin root *gen* which has to do with birth, race and creation)—really dates from the twentieth century.

The real founder of genetics was an obscure Augustinian monk, abbot of a monastery in Brünn, not far from Vienna. His name was Gregor Johann Mendel and he was born in 1822. This humble seeker after truth loved to work in his quiet cloister garden; and he completed many experiments. Year after year he mated different kinds of peas and carefully noted the results. His findings were published in a small scientific journal but attracted little notice. The good friar's attention was taken up by the administration of his abbey and he died almost unknown in 1884.

One important fact Mendel found from his garden experiments was this: certain inherited qualities are strong and others are weak. The stronger qualities he called *dominant*. He found that when tall peas are

MENDEL'S LAW OF HEREDITY



A tall plant (of pure tall stock) mated with a dwarf plant (of pure dwarf stock) produces all tall plants, F_1. Since F_1's parentage was not pure, they are called hybrids. They produce F_2, a mixed generation—25 per cent tall, with no dwarf genes; 25 per cent are dwarf, with no tall genes; 50 per cent are hybrid tall like their parents. The offspring of the F_2 hybrid tall plants are—25 per cent pure tall; 25 per cent pure dwarf, and 50 per cent hybrid tall. All following generations of hybrid tall plants are in the same proportions.

crossed with short peas, the offspring are not of middle height, but all are tall.

Tallness in peas is dominant, whether the tall plant furnishes the egg-cell or the pollen. But this is only the beginning. The second generation produced by these tall offspring of tall and short parents is *not* all tall, as we might expect. For every three tall offspring we find one short one. The shortness is *recessive,* that is, it remains hidden for one generation and then appears again. Nor is this all. The short plants of this second generation will all breed true, that is, they will produce only short plants. One-third of the long plants will also breed true, but two-thirds will give long and short plants in the proportion of three to one. The picture will make this clear. Mendel found that the color of flowers, the color and shape of the seeds and still other characters follow this law. Later it was found to apply to many qualities of animals as well, such as color of eyes, length of coat, presence or absence of horns and comb, etc.

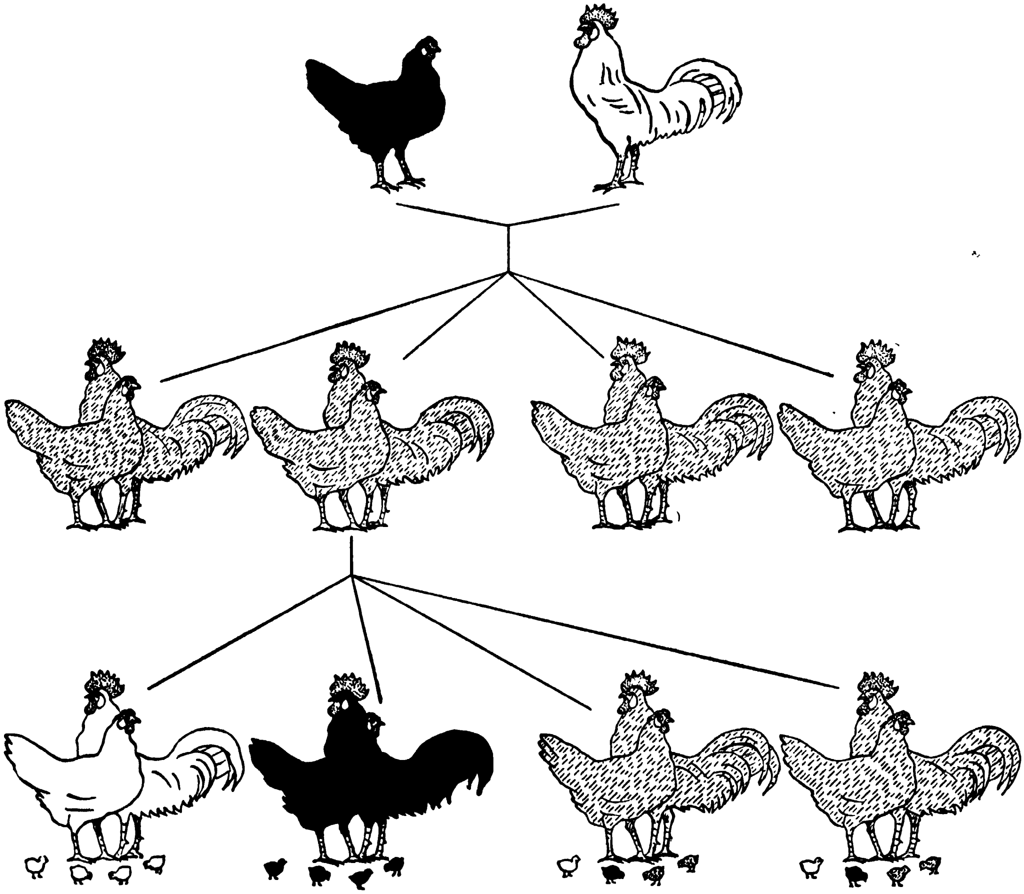
Mendel's great discovery, so important in science, as well as in practice (because it shows how certain qualities may be bred in plants and animals), gathered dust in libraries for more than thirty years. Then suddenly, around 1900, three scientists rediscovered the Mendelian Law, and the new study of genetics began. Now we know many facts about heredity.

Many qualities are to-day known to be dominant over others. One such is dark eye color in man, which behaves just like tallness in peas. If you belong to a large family in which both brown and blue eyes occur you can check the laws of Mendel at first hand. A blue-eyed mother from a family with only blue eyes, and a brown-eyed father from a brown-eyed family, will have children that have only brown eyes. If these children marry similar brown-eyed mates, they will have one blue-eyed child for every three brown-eyed. These proportions can be seen only in large numbers of children. One pair of parents may have only two children and these may very well fail to bear out the law. But with a large number of children from such parents the proportion will be exactly according to Mendel's law.

U.S.D.A. photograph by Forsythe

When unlike qualities mate, one quality may dominate, as tallness in peas (page 5614). When neither trait is dominating, we see a blending, as in this picture. A black sheep and a white sheep have a dark lamb, but with a black nose. The black nose is dominant. (The baby is the biggest member of this family.)

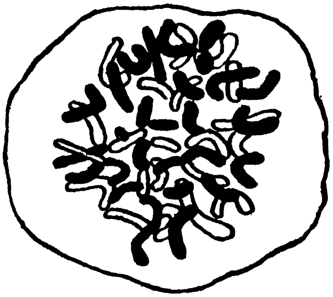
Not all qualities are completely dominant or recessive. The first generation may combine the qualities of the two parents; that is, a short mother and a tall father might have children of middle height. In that case one-fourth of the second generation will follow the grandfather, another fourth the grandmother, and one-half will continue the mixture of the parents. Often, however, the matter is much more complicated.



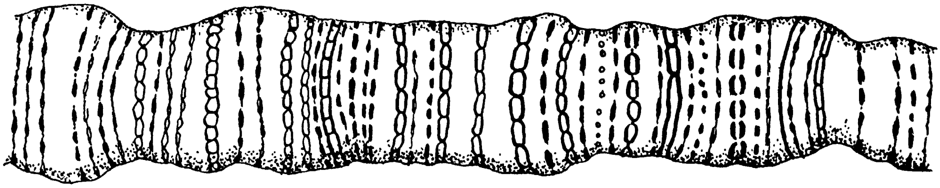
On page 5615 you saw a sheep family—black father, white mother and lamb of blended color. Here is another example of blending. A black hen and a white rooster have buff ("in-between" color) chickens. The next generation is: 25 per cent white; 25 per cent black; 50 per cent buff. The chicks of this buff generation breed 25 per cent white, 25 per cent black and 50 per cent buff; and that is the way all the buff fowl will continue to breed. This is the proportion which Mendel discovered with tall and short peas.

While thus the orderly results of the working of heredity began to become known, the inquiry as to how the tiny germ-cells could bring them about also went forward. The great German, August Weismann, held that something he called the germ-plasm was the stuff of heredity. This he placed in the nucleus of the germ-cells. The microscope has taught us a great deal about the cell nucleus. Parts of the cell nucleus can be stained with dyes and are therefore called chromatin, from the Greek word for color. In this chromatin Weismann placed his germ-plasm which he believed to be very stable. He came very close to the truth. When cells are about to divide, the chromatin is seen to separate into a number of thread-like bodies which are called chromosomes (color bodies). See the picture on page 5617. It seems certain to-day that these chromosomes are the carriers of bodily heredity. They appear in every cell—plant, animal or human—and their number varies with the species. Some kinds of living things have only a few in each cell; man has 48. It has been learned that the chromosomes generally come in pairs and each pair has a different shape. When a cell divides, each chromosome divides and re-forms too.

Nearly all cells have the full number of chromosomes. The one important exception is the germ-cells. When these ripen they undergo one last division in which only one of each pair of chromosomes gets into each germ-cell, which thus has only half the usual number—24 instead of 48, in man. The reason for this is easy to see. In the creation of a new individual, two cells must unite. If each had the full number of chromosomes, the new cell would have twice the usual number. So Nature has wisely provided that of all the cells in the body, the ripe germ-cells alone shall have only half a supply of chromosomes, so that their union will produce a cell with the usual number, half supplied by the father, the other half by the mother. As we have seen, the new cell that comes into being in this way gives rise to the offspring.



The 48 chromosomes of man, as they appear in a cell. There are 24 pairs, and no two pairs are exactly alike.



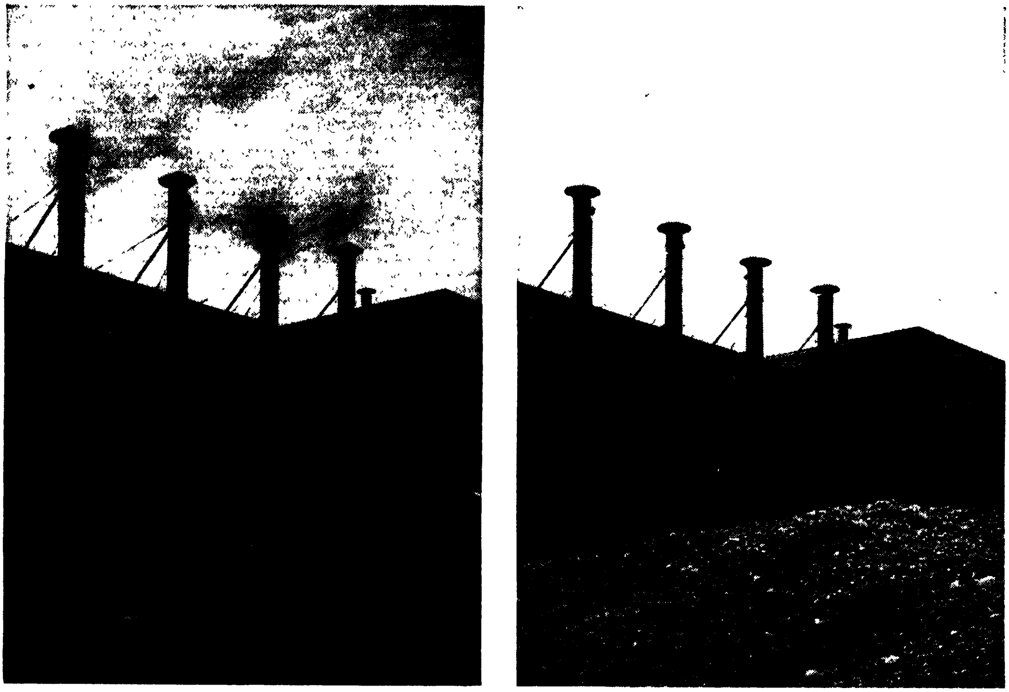
A drawing of a chromosome of a salivary gland seen under a powerful microscope. The lines around it, that look somewhat like beads, may be genes. Scientists are still only at the beginning of the study of genes.

The magic story of heredity is not yet ended. The chromosomes themselves are not the smallest units of heredity. Scientists have many reasons for believing that they are made up of much smaller units which are called genes. These lie along the length of the chromosomes, like beads on a string. In the gene we seem to have the final "atom" of heredity, though the gene is not actually thought of as an atom in the sense in which we speak of an atom of hydrogen, but instead as a very complicated molecule—a different kind for each gene. No one has ever definitely seen a gene, any more than anyone has ever seen an atom; yet so much is known about the genes that the positions of many of them along the chromosomes have been mapped and the qualities they control are known. Each gene—there are, of course, hundreds—controls only a tiny part of our heredity, and often several are necessary to determine so little a thing as the color of the eyes. We may liken the genes to a pack of cards, which in the germ-cells is shuffled and arranged in many different ways, dealing each of us a different "hand."

What we have told you here is only the beginning—only a small part of all that is known. The details are difficult to explain, and scientists who have made a life-study of the subject do not yet know how genes are linked up together, or how it is that unexpected traits sometimes appear suddenly in a plant or animal. They only know that something has happened to the genes in the germ-cell, and an individual appears that is different from both parents, and from all its brothers and sisters, and the different trait will breed true. We call such a new individual a mutation, a mutant, or a sport. Plant- and animal-breeders are always on the lookout for sports with useful and interesting traits. When they find one, they breed it carefully to "fix" the trait, and that is one way by which new varieties of flowers, fruits, poultry and animals come to the market. The other way of securing new types is by crossing varieties or species. The first white mink was a sport. The white blackberry is the result of crossing.

IS THERE ANY WAY OF CHANGING GENES?

Yes, genes are sometimes changed when a plant is subjected to powerful X-ray or other radiation. Scientists believe that one of the greatest threats of the atomic bomb is to the genes of animals and plants, through radiation. Such changes are at the mercy of chance. No method has yet been discovered of changing genes to produce a desired effect.



Koppers Company

Electrostatic devices in the stacks on the right eliminate the smoke and recover valuable materials.

WHAT IS SMOKE MADE OF?

Smoke is the result of imperfect burning. Most of the substances from which we get much smoke, if they were properly burned, would form nothing but gases, which we could not see, and which would very soon fly away. But men have not yet invented a furnace that will burn a fuel completely, without any smoke, though some factories have installed expensive devices that do the trick. So we burn the coal or wood or oil or other substance only partly, and small specks of it, unburned, are carried up the chimney or smokestack. The chief substance in smoke is simply fuel in specks of various sizes.

Smoke makes black fogs in many cities, and cuts off a great quantity of daylight, besides making everything dirty, destroying plants and trees, and filling our lungs with dirt that we never get rid of.

WHY DOES GLASS NOT BREAK IF PUT INTO COLD WATER AND BOILED?

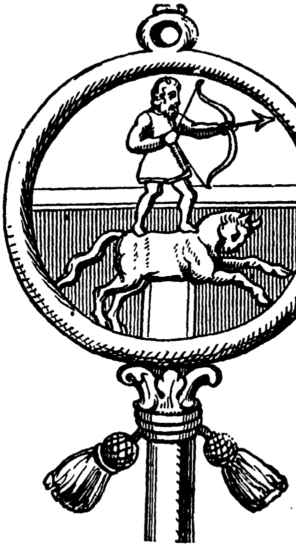
Almost everything gets bigger, or expands, when it is made hot; and it gets smaller, or contracts, when made cool. If, then, we take a thing all in one piece and do not heat every part of it to the same extent at the same time, something will have to give. If a tumbler is put into water, and then the water is boiled, all the parts of the glass expand equally as it gets hotter. The whole glass becomes bigger. There is no strain between the inside and the outside, and so there is no reason why it should break. When we pour boiling water into a tumbler, the inside grows hot and expands, while the outside stays the same. The result is a crack, when the force of expansion on the inside becomes stronger than the attraction between the molecules on the outside of the glass tumbler.

WHY DOES HOT WATER CRACK THICK GLASS MORE EASILY THAN THIN?

As the answer above tells us, hot water cracks thick glass because the heat causes the expansion of the inner layer of the glass while the outer is still cool and unexpanded. The expansion of the inner layer tears the outer layer, and so the glass is cracked right through. Heat penetrates the thin glass more evenly, so that the outer layer expands at about the same speed as the inner one.

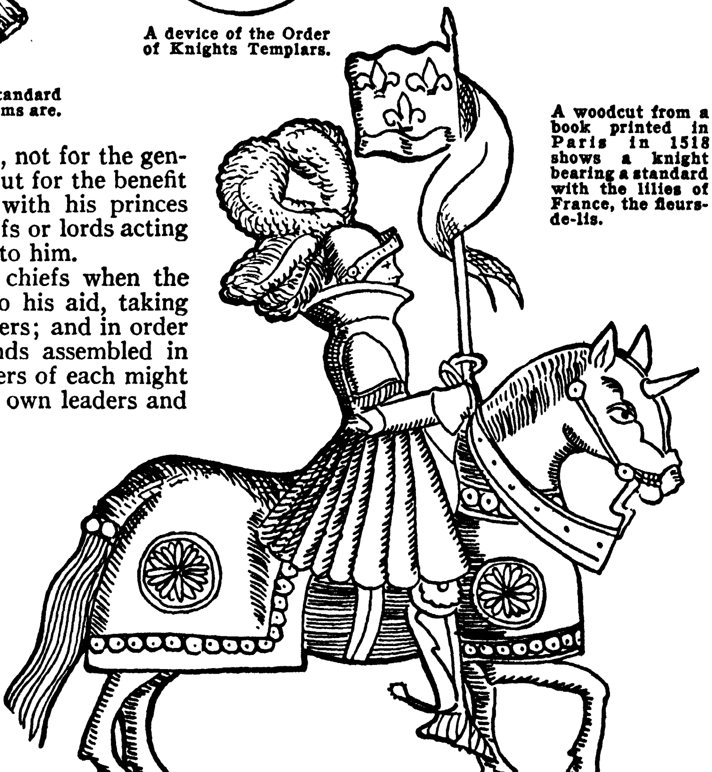
WHAT IS MEANT BY HERALDRY?

Heraldry is a survival from the days of long ago, when the social life of the people was very different from the life we live. The country was organized then, not for the general good of the majority, but for the benefit of the few—for the king with his princes and a small number of chiefs or lords acting under him and responsible to him.



This ancient Assyrian standard shows how old heraldic emblems are.

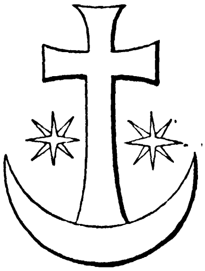
It was the duty of the chiefs when the king was attacked to go to his aid, taking with them a band of retainers; and in order that among the many bands assembled in the king's army, the members of each might be able to distinguish their own leaders and comrades, each lord had an emblem, or symbol, embroidered on his garments and trappings, and on a banner borne aloft, and at a later period on the coats of his followers. Women usually embroidered the emblems with painstaking care.



A woodcut from a book printed in Paris in 1518 shows a knight bearing a standard with the lilies of France, the fleurs-de-lis.

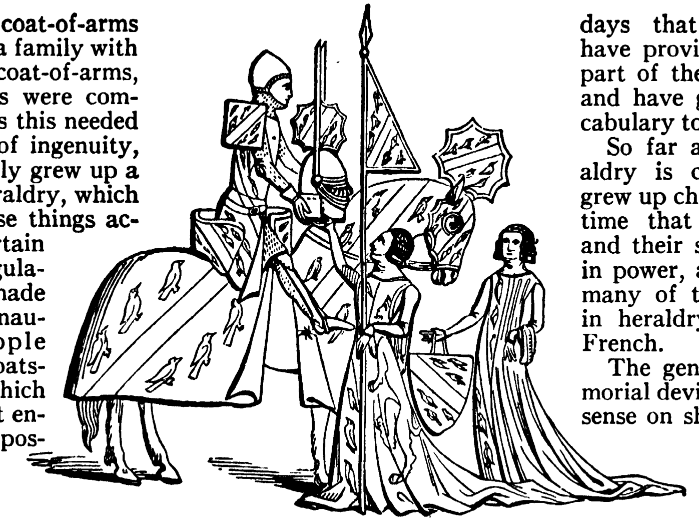
Very often the chosen symbol would have some direct reference to the lord who wore it. Thus, if an ancestor had been killed in a fight with a lion, the lord would perhaps choose a lion as his emblem; if he himself were famous in falconry he might choose a hawk; if he were of a humorous turn of mind he might select for an emblem something the name of which was a play or a pun on his own name, such as, for instance, a castle near a river for the name of Castleford.

In course of time the symbol became the distinguishing sign of the lord and his family, to be used on all occasions. It would be painted on his ceilings and sculptured on his walls, but its first use was in battle, and, as it was a part of the armament of the lord, it came to be known as his arms. Embroidered on his surcoat it was called a coat-of-arms, and as the shield bearing the emblem was a prominent part of his outfit in war it came to be the custom, wherever the arms appeared, to draw them inside a shield.



A device of the Order of Knights Templars.

When members of one fam-

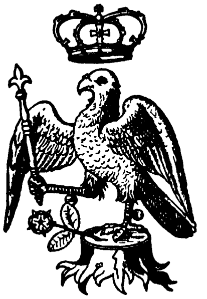


In early days heraldic emblems were even used on ladies' dresses.

ily with a coat-of-arms married into a family with a different coat-of-arms, the two arms were combined, and, as this needed a good deal of ingenuity, there gradually grew up a science of heraldry, which arranged these things according to certain rules; and regulations were made to prevent unauthorized people from using coats-of-arms to which they were not entitled. The possession of a coat-of-arms thus became a trustworthy badge of birth and breeding.

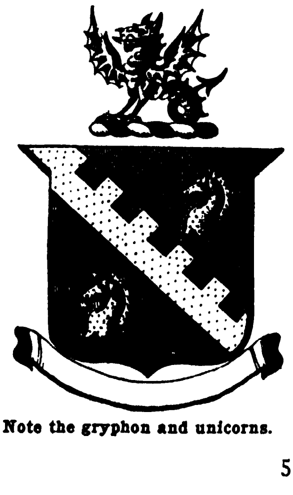
Many of the symbols that were used for arms were quaint and homely—birds, lobsters, beehives, acorns, grapes, wheels, sheaves, ships, leaves, musical instruments and so on. Gradually, as family after family combined their arms, these became very complicated.

Heraldry is very useful to-day in unraveling the past, for it enables those who understand it to trace the history and pedigree of ancient families and important personages, whose early story might otherwise be lost. It is in many ways the handmaid of history and has occupied the attention of many serious students of the past.

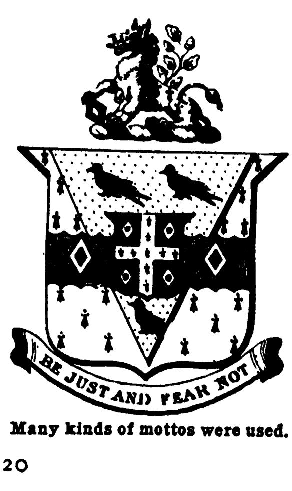


Anne Boleyn's emblem.

Nobody can say exactly how far back it goes, but from the very earliest period we find it was the custom for individuals and communities to be distinguished by some sign or device, and this is all the origin of heraldry. It is because war and the chase were the chief business of men in olden days that these things have provided so large a part of the symbols used and have given their vocabulary to the science.



Note the gryphon and unicorns.



BE JUST AND FEAR NOT

Many kinds of mottos were used.

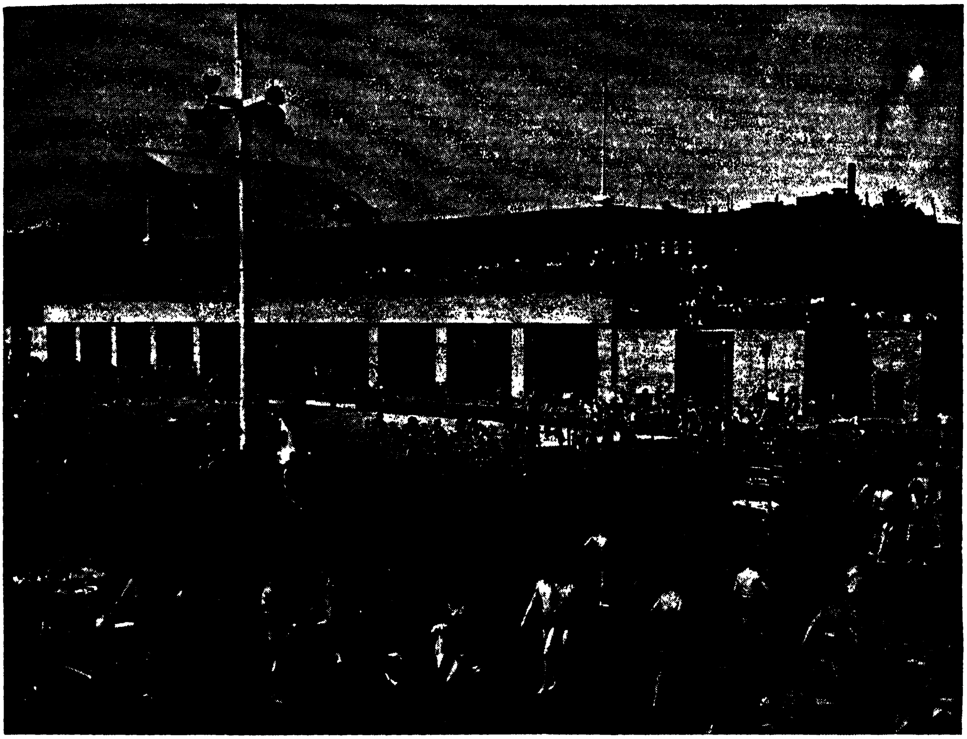
So far as English heraldry is concerned, this grew up chiefly during the time that the Normans and their successors were in power, and as a result many of the words used in heraldry are Norman French.

The general use of armorial devices in the strict sense on shields and banners is supposed to have begun about the middle of the twelfth century. In the First Crusade (1096-1099) the shields of the Christian knights seem to have been plain and they had no designs emblazoned on their banners, and in the Second Crusade we are not sure that there were armorial bearings.

But the idea was beginning to germinate at the time of the Norman Conquest, for on the shields of both Saxons and Normans there are simple figures something like armorial bearings, including dragons and crosses. These seem to have been the early stages of heraldry as we understand it to-day. Tournaments, of course, with all their pageantry helped to bring armorial bearings into general use, and arms soon became one of the characteristic features of the Middle Ages.

What looks to us to be the left-hand side of the shield is called the dexter or right-hand side, and what looks like the right is the sinister or left. The viewpoint is that of the shield-bearer.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5739.



What a boon such an open-air swimming pool is for city youngsters in hot weather! This pool is in Brooklyn, N.Y.

WHAT A GREAT CITY DOES FOR ITS CHILDREN

CHILDREN are quite as important in the life of a nation as grown people, because the children in each generation are the grown men and women of the next generation. When they become men and women they will be responsible for the government of their country; for making its homes; and for carrying on the work of the world in every branch of human activity. It is therefore urgently necessary for the nation's future welfare that its children be given every chance to grow strong bodies and vigorous minds.

In the United States the Federal government and the various state governments give advice and financial help to communities for the benefit of their children. Cities such as Boston, New York, Chicago and many others spend a great deal of money and effort to see that the minds and bodies of their little ones are properly cared for—that the children are well fed and clothed, that they have skilled medical attention, and that they are properly housed and properly taught. Most parents are eager and anxious to do everything possible for their children's welfare; but many parents can not afford to do all that is necessary, and not all of those who can afford it know what is best to do. For that reason all of the people who pay taxes to support their city government are glad to have a certain amount of the tax money go to the care and education, not only of their own children, but of all the children of their community.

New York City, with its huge population, much of which is made up of foreign-born people, has developed through the years an especially worth while system of child-welfare work and education. There are several city departments and bureaus, some or all of whose work has to do with children. Among these are the Board of Education, the Department of Hospitals, the Department of Parks and the Department of Welfare. We shall tell you of some of the things that are done by these branches of the city government.

A most important form of help carried on by one of the bureaus of the Department of Welfare is called Aid to Dependent Children. In a large city there are always many families in which the breadwinner is dead, or too ill to work or out of work for various reasons. Usually the breadwinner of a family is the father, and when the father is gone there is great danger of the family breaking up, or not getting the proper care because the mother can not earn a living and still look after the home. When this happens in New York the mother or grandmother or legal guardian of the family is given an allowance of money to provide for each child under the age of sixteen. In this way the family can be kept together in their own home. The number of children cared for in this way varies from time to time, but in December, 1945, there were 42,710. The cost of this Aid to Dependent Children is divided between the city, state and Federal governments. In addition to these children there were 10,810 others under sixteen years of age who were receiving home relief under another program, this one being paid for jointly by New York City and New York State.

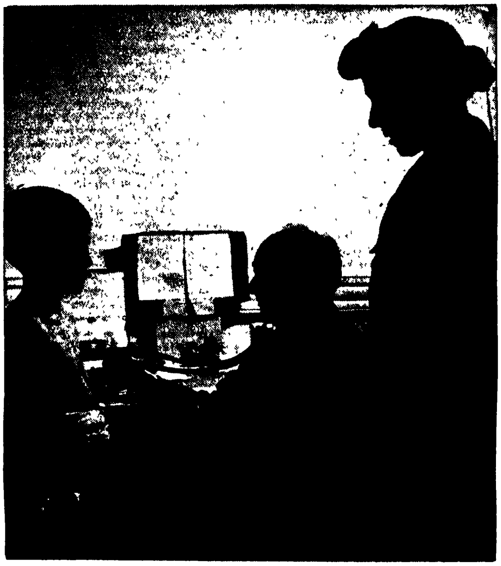


Photo by Charles Phelps Cushing

The school doctor is testing the boy's heart action.

There are other children cared for by the city in institutions and foster homes. New York City does not operate such institutions itself. They are maintained by the great private welfare societies and by the important religious bodies. Each child is placed through the Bureau of Child Welfare in an institution of his or her own religious faith, and the institution makes arrangements to place the child in a proper kind of foster home. The entire expense is, however, borne by the city. At the end of 1945 there were about 15,000 children being cared for in this way.

New York City has a system of public schools which, although far from perfect, accomplishes wonders with the children entrusted to it. These children come from every kind of home background. They are of different racial and religious origins. Some belong to prosperous and well-educated families; other are from families who live in the slums and have little chance to better their lot. But wherever the children come from, when they enter the public schools they receive an excellent education, not only in regular school subjects, but in good manners, personal cleanliness and good health habits. So far as it is possible to do so, each child is given an opportunity to develop any unusual talents that he may have. The schools work with the public libraries, the museums and with various other city departments to bring cultural knowledge and activities within the reach of the city's children.

There are special schools or classes for children who are crippled, or who are deaf, or children with weak hearts, in short, for those whose health will not permit them to attend ordinary schools. Then there are the high schools. These include a number of vocational high schools, where, in addition to the regular program of studies, the pupils can learn a skilled trade which will help them to earn a good living when they leave school. The city also maintains four great colleges, where, as in all the city schools, books and tuition are paid for by the city. Many boys and girls find it necessary to go to work before they have finished college, or even high school. If, however, they are ambitious, there are evening high-school classes at which they can carry on their studies. All of the city colleges also give evening and summer courses.

THERE IS MUCH TO BE GAINED FROM PARENT-TEACHER MEETINGS

As in other towns and cities in the United States, the teachers and parents of the public-school children try to work together to understand the children's needs, both at home and in school. Some of the parents themselves need to learn much about the best ways to raise their children, and they gain a great deal from the parent-teacher meetings. Often these meetings are addressed by doctors, health nurses or specialists in child training and education.

The Department of Education and the Department of Public Health work together to protect and improve the health of the school children. Physicians and visiting nurses investigate each child's health and go to the homes to advise the children's parents. There are dental clinics and eye clinics and other clinics for children who have any physical deficiency that may injure their health.

Under the Health Department there are child health stations in all parts of the city, where mothers may get advice and training in caring for their children from birth on up to high-school age. Clinics are held at these health stations, and mothers can buy milk for their little ones at a lower rate than at regular dealers. Because of the wonderful work done by the Health Department the death rate among infants of less than a year has been lowered from 333 per 1,000 in 1915 to less than 40 per 1,000 today.

Under the Department of Hospitals special hospital units take care of children who have contracted either pulmonary tuberculosis or bone-and-joint tuberculosis. Sunlight and special food and medical treatment are given these children. Special provision is also made for children who come from homes where there is tuberculosis, but who do not themselves have the disease. They are taken care of and their health is built up so that they will not get this dreadful plague of modern times.

Not all of the little tubercular children can be taken to the regular tuberculosis

Photo by Charles Phelps Cushing

New York public schools start the new term with school health registration. Each child is asked to bring his birth certificate and other health records.

hospitals for treatment. Roof camps have been established where such children can spend the days in the open air. The patients arrive at the camp each morning at nine o'clock and are at once given a glass of fresh milk with a raw egg beaten into it. Then the children have their lessons almost as they do at school. At noon a good, wholesome dinner is served, and in the afternoon another glass of milk with a raw egg is given. Promptly at five o'clock the camp closes and the children go to their homes.

Nurses and physicians visit the homes of the young patients and see that the lightest and airiest room is given to the sick child. They see that the linen and utensils used by the tubercular patient are washed separately from those used by the rest of the family; and they give tickets for two quarts of fresh milk and three raw eggs a day. The day camp is one of the many wise agencies provided by New York City in the struggle against tuberculosis.

OPEN-AIR FUN AT PLAYGROUNDS, ROOF GARDENS AND SWIMMING POOLS

Besides helping the sick children back to health, the city does much to keep the healthy children robust and happy, and to provide them with healthful recreation outside of school hours. For this purpose it has established open-air playgrounds, roof gardens, recreation piers, swimming and wading pools, garden plots and athletic grounds, and has secured trained young men and women to supervise the play and to teach the children games and other activities.

The settlement workers among the children of the slums count the roof gardens as one of their most valuable helps. All of the newer public schools in New York are built with roof playgrounds inclosed with wire netting and floored with tile. Here the children learn baseball and basketball and even tennis, and in many cases gymnasium classes and dancing classes are held. Some of the model tenements are built with roof gardens, and many of the day nurseries of the city have summer roof gardens, where the little ones left in the care of the nurses can play in the open air and the health-giving sunshine.

There are playgrounds for older boys and girls as well as for the little ones. Some of them are in the public schools, some adjoin the school houses or branch public libraries. In extremely crowded districts certain blocks are often set aside by the police as play streets, and no traffic is allowed to use them during the children's play hours. In the hot weather the Fire Department sends men to turn on the fire hydrants in some of the streets, and the children put on swimming suits or sun suits and run and dance in the cool spray.

Photo by Charles Phelps Cushing

School children in New York and many other cities enjoy this sort of "visual education," especially when the movies are about things strange to cities.

PRESERVING OLD-WORLD DANCES IN THE NEW WORLD

Dancing teachers go to the public schools and to the recreation piers which have been built at various places along the Hudson and East rivers, and teach the children folk dances of the countries from which many of their parents or grandparents came. From time to time exhibitions of these dances, performed in costume, are given in the public parks. This is one of the many ways in which the life and culture of our country is being enriched by colorful Old World customs.

One of the most important educational and recreational services that the city can give to its people, grownups and children alike, is a good public-library system. New York City has two separate library systems, one of which serves the huge borough of Brooklyn, and the other serves the other four

Photo by Charles Phelps Cushing

City parks and zoos afford splendid opportunities for school children to learn by observing nature. These New York children are visiting the rock garden at the Bronx Botanical Garden. Later on they may pay similar visits to the aquarium, the natural history museum, and the planetarium. Most cities have such facilities.

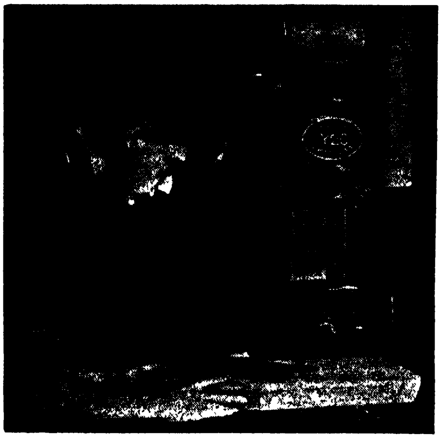
boroughs. These libraries do a wonderful work, though it must be admitted that there are other cities in the United States which have, in recent years, spent much more money per person on their library systems than has New York. A report made in 1946 showed that Cleveland, Ohio, for example, spent $2.27 for each person in the city, while New York spent only 51 cents per person. However, a large proportion of the library service in New York is centered on the children. Anne Carroll Moore, the pioneer of children's libraries in the United States, makes the following interesting statement:

"America was the first country in the world to give boys and girls a place of their own in a public library. The first children's room to be included in an architect's plan and equipped for the comfort and convenience of children from picture-book to high-school age was that of the Pratt Institute Free Library, Brooklyn, New York, opened in 1896. Its low reading tables and small chairs of different heights, designed from specifications of a well-known specialist in hygiene, have become a familiar feature of other children's rooms. Their measurements have been standardized and are accepted as part of the equipment of every American public library, large or small, and they have been copied in Sweden, Norway, New Zealand, France, Belgium and in other countries.

"The Central children's room of the New York Public Library has a cheerful red-tiled floor and deep window-seats where boys and girls love to curl up and read by the hour. In many of the branch libraries in New York, Brooklyn, Utica, Cleveland, Detroit, St. Louis and other cities, there are fireplaces with andirons holding blazing logs on winter days round which groups of children sit on settles, benches or in armchairs. Children's rooms are of different sizes. The Brooklyn Public Library has one entire big building for children in a crowded district. The Carnegie Library of Pittsburgh has several rooms opening into one another. In the new central building of the Cleveland Public Library the children's room is named for Lewis Carroll, and a room for boys and girls of high-school age on the same floor is named for Robert Louis Stevenson.

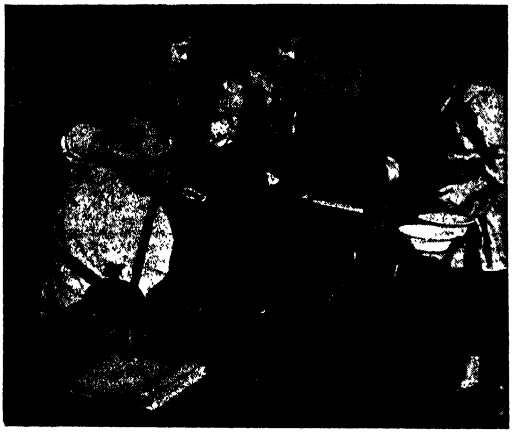
"The most complete and beautiful small

LEARNING BY DOING



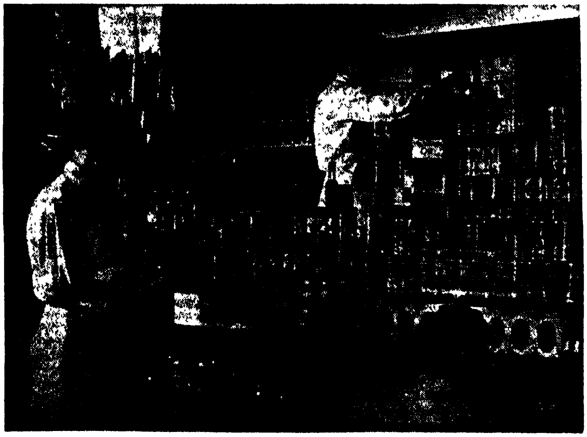
Photos from All the Children, Board of Education, City of New York

In trade schools many boys and girls learn ways to earn a living: at the left, woodwork; at the right, food trades.



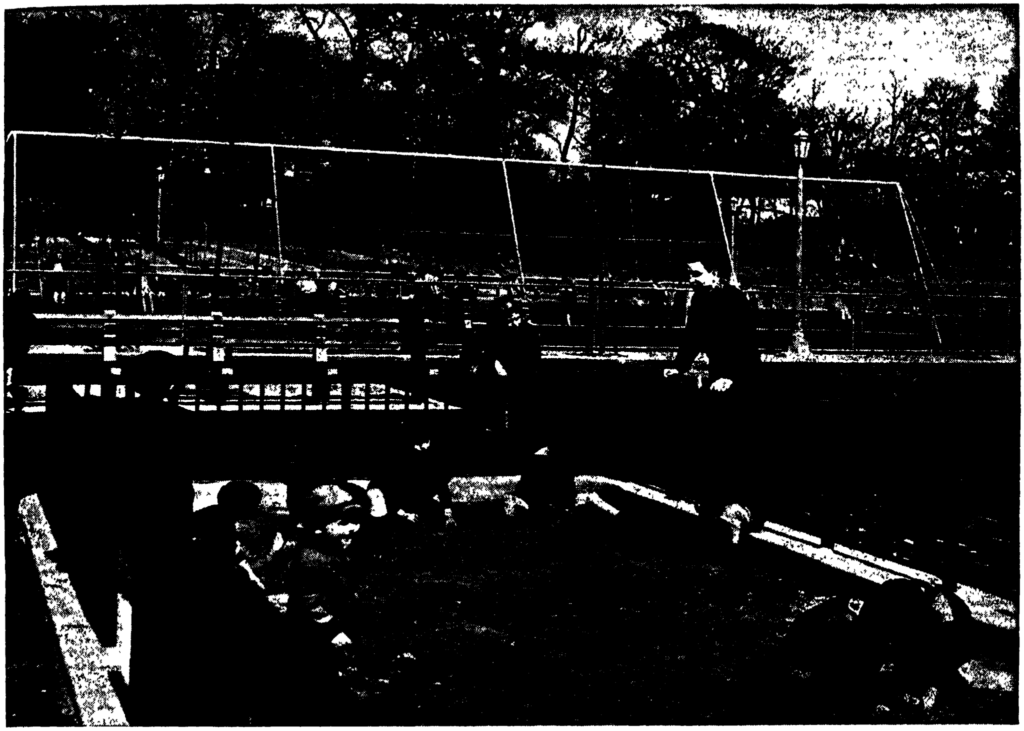
A group learning to print by lithography.

These girls are taking the course in homemaking.



Learning to earn a living as retail store clerks, these boys are pricing goods and arranging stock on the shelves.

Here are several boys who hope to become garage helpers and some day, perhaps, expert mechanics.



Most modern city parks make generous provision for play grounds . . . everything from sand boxes, swings, seesaws and slides for the younger children to tennis courts, ball fields, skating arenas, and even golf courses for the older boys and girls. It costs less in taxes to keep people well this way than to take care of them when sick.

library building yet designed for children is at Westbury, Long Island, New York. It is a memorial to Robert Bacon, late ambassador to France. At one side of the library is a bird sanctuary with a deep pool, and in the fir trees and shrubbery there are sun parlors for the birds. Inside the library there is a notable selection of books about birds and gardens, and on the wall is a wonderful decorative map of Long Island, showing all the native birds and flowers in colors. This library has many rare old children's books and pictures, and plenty of new books for the boys and girls to take home are in daily circulation.

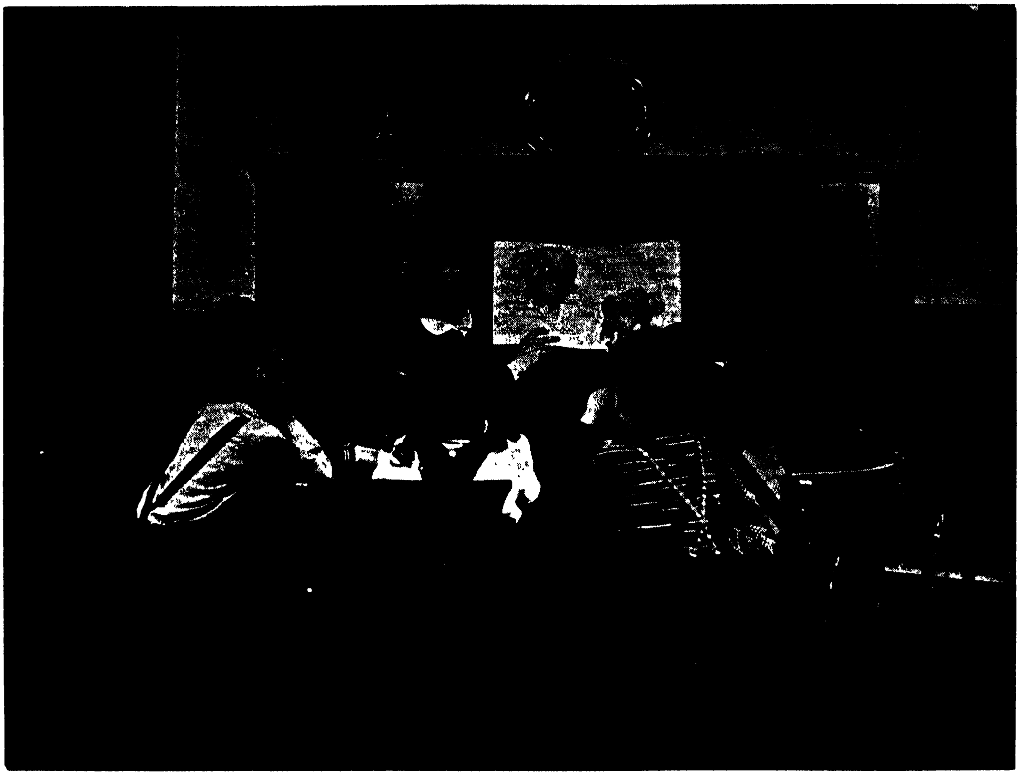
"One of the most intersting things that happen in a library for children is the weekly story hour, which often begins on Hallowe'en and ends for the season in April or early May. All kinds of stories are told—fairy and folk tales, stories from history and legend, the great national epics, and stories of high adventure. The selection depends upon the ability of the story-teller and the tastes of the children. The library story hour should broaden and strengthen tastes for real literature and help to promote the love of reading for reading's own sake. Library reading clubs for older boys and girls are held in many libraries, and in these clubs very lively discussions of books take place.

"Every children's library room needs a good-sized colllection of books for school reference and general reading in the room. The best illustrated books, such as Boutet de Monvel's Joan of Arc, Howard Pyle's Book of the American Spirit, and Randolph Caldecott's Picture Books, belong in such a collection. But the most important things to have in any children's library are a fine selection of books with plenty of duplicate copies, good pictures, and a librarian who knows these books and other books well enough to introduce them effectively without spoiling the fun of boys and girls who like to discover books for themselves.

"The work of a children's librarian requires special training and courses of continuous reading, for she is expected to advise parents and teachers about children's reading, as well as help children of widely different tastes and ages in their selection of books for reading at home and in the freer use of books as aids to study in school and out.

"Classes of children from public and private schools frequently spend an hour of school time in the children's rooms of public libraries. Sometimes they ask for a story to be told, sometimes for a talk about books or for a reading-aloud circle, and sometimes they want to spend the whole hour browsing at bookshelves or reading tables.

"The children's library has been well called 'a nursery of good citizenship.' Its rules are very simple—clean hands, and respect for the other fellow who may wish to read quietly. 'It's better than any school,' said one small boy, 'because you don't have to go unless you want to, and you can go home when you please.' To make of a children's library a place to which children like to come often and sometimes to bring their fathers and mothers and grandmothers—a place from which there flows continuously a stream of interesting new book associations alongside the old and tried; a place that never grows static or stale, but seems fresh and alive to each new generation of readers—this is to make a successful children's library. Attractive physical equipment merely helps express the idea—'a new idea in education' it has been called by visitors from across the Atlantic."



Courtesy, the N. Y. Public Library

Most libraries have a children's room, with specially trained librarians to help the children pick out books which they can enjoy. These children are attending the weekly story hour at one of New York's branch libraries.

Miss Moore's remarks give a true and vivid picture of the aims and ideals, not only of children's librarians, but of all the men and women in our cities whose aim is to help build up the next generation of citizens. Our great cities already do much for their children, but all of them are constantly striving to improve and expand this vitally important service to the community, to the nation and to the world.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 5653.

The powerful pike, a lurking glutton that traps its prey with great backward-curving teeth.

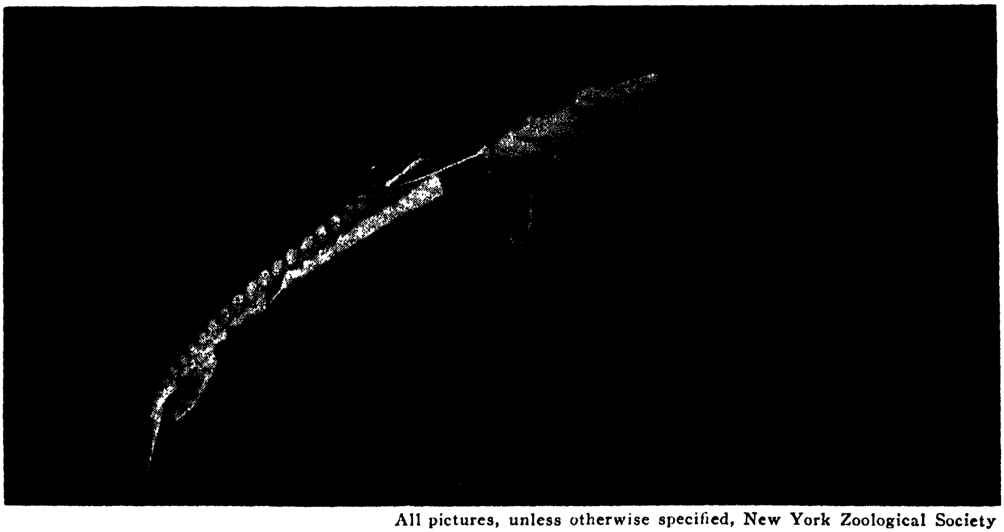
FISHES OF RIVER AND LAKE

THE stream, the lake, the river have their teeming life in many forms. They have their stay-at-home citizens who covet no more than one straight little run of reedy water. Some must stay where they are because they can not go down toward the river's mouth lest salt water should kill them; some live in water in the estuaries, which is neither fresh nor salt, but brackish. The river has its explorers which go forth from their homes never to return. Others, as the salmon and trout, change their method of living and swim from placid streams out into the ocean, and come back in due season to their nursery grounds in fresh water.

Battle and death are the normal sequence of events that lead fish to their dinners in our inland waters. The big fish eat lesser fish, lesser fish eat smaller fish, the smallest eat the water fleas and other insects, and the water fleas and their comrades eat the green vegetable life of the stream.

Among the giants of the fresh-water fish are the sturgeons. The greatest of them may be as long as eighteen feet; a specimen may weigh hundreds of pounds. The Pacific sturgeon has been known to reach a length of thirteen feet and to weigh a thousand pounds. The lake sturgeon is much smaller, and so are the short-nosed sturgeon and the shovel-nosed sturgeon.

Possibly many larger ones fall to the fish-



All pictures, unless otherwise specified, New York Zoological Society

A fresh-water giant, the sturgeon, which may be as long as eighteen feet and weigh hundreds of pounds. Man values it most for its roe, a solid mass of eggs, which, prepared and salted, becomes the costly delicacy, caviar.

ermen who yearly line the banks of Russian rivers as the fishes swarm in hundreds of thousands from the sea to lay their eggs in the fresh water. It is not so much the flesh of the sturgeon the fishermen seek as the roe, which is a solid mass of eggs, three million and more to a single sturgeon. This roe, prepared and salted, is preserved and sold all over the world as a costly luxury, caviar.

In appearance the sturgeon is as terrifying an object as a swimmer is likely to meet in the water, for its long body is covered with a heavy mail of bony plates, like a suit of armor. Yet the sturgeon is a harmless fish, toothless, a mere grubber in the sand and ooze of sea and river bed after worms, little fish and small life in shells.

There is nothing so impressive in the workmanship and build of a perch, yet the perch is a thriving, lusty fellow, abundant in the lakes and clean streams of the eastern part of North America. Instead of a coat of armor for defense, this fish has invisibility, or something near it.

The yellow perch, with its stripes, is a beautiful example of camouflage in the water. The keen-sighted angler may detect the presence of a salmon without actually seeing it; he discerns the shadow cast on the gravel as the gliding salmon swims above it. But the perch is more likely to swim over vegetation where such a shadow can not be seen easily, and the stripes break up his outline and render him still less visible.

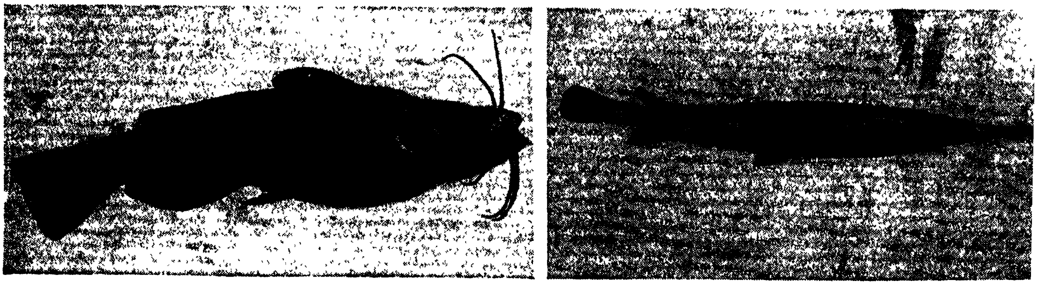
The walleyed pike, or pike perch, is found in the Great Lakes and in many other lakes and streams in the eastern half of the continent. It may grow to be as much as three feet long and weigh as much as twenty-five pounds, but most specimens are much smaller. A near relative, the sand pike, or sauger, is found much farther west.

Thanks to their great spiny fins, the perch are audacious fish. The sunfishes, of which there are many species, are common in many American rivers and can be regarded as modified perch, with the same spiny fins. If the sunfishes were a little larger, they would be important food fishes, but only a few species grow to be more than six or eight inches long. The common sunfish, or pumpkin-seed, is eagerly sought by small boys. It fights as hard as a much larger fish.

A sebago, or landlocked salmon—it spends all its days in fresh water and never knows the call of the sea.

The fresh-water basses also belong to the perch family. The rock bass is common in most of our lakes and rivers except in the extreme West. It grows to be as much as twelve inches long, and loves to dwell in deep water near rocks. It is a voracious feeder and eats many minnows.

The black bass, both small-mouthed and large-mouthed, are found in many of our rivers and lakes, and have been introduced into European waters, where they do well. Both are excellent food, and fishermen like them because of their gameness. Some fishermen say that they are harder to land than either salmon or trout. The white bass belongs to an entirely different family. It is common in the region of the Great Lakes. The striped bass spends most of its time in



Both pictures. American Museum of Natural History

Left, the bullhead, a catfish, armed with prickly spines; right, the long-nosed gar, which loves shallow, reedy places.

The common sunfish, fair catch for small anglers.

salt water and enters the rivers only to spawn. It is common on the Atlantic coast and has been introduced into the Pacific. Striped bass weighing over a hundred pounds have been taken, but such large specimens are becoming rare.

The catfish family is a very large one and is found in the warmer waters of the world. South America and Africa have most of the species, some of which live in salt water. North America has more than thirty fresh-water species, but none is native to Pacific waters. The blue cat is common in the Mississippi and elsewhere, and attains a great size. It is a good food fish. There is a catfish in the Great Lakes and in certain Canadian lakes that some scientists think is the same fish, but it does not grow to be so large. Several other species are caught for food.

Belonging to the same family are the bullheads known to every small boy. The common bullhead, or horned pout, is found in most of our inland waters. It loves the muddy bottoms of streams and lakes. It has been introduced into some of the streams of the Pacific coast and thrives there. It is greedy and usually swallows the hook, no matter what bait. Every boy who has ever caught a bullhead has been pricked by the spines behind its head. We are told that the old bullheads look after the young as an old hen would care for her chickens. In Europe the name is applied to another fish, which is known also as the miller's-thumb.

Another spiny fish is the stickleback, found in all the colder waters of the Northern Hemisphere. There are about twenty species, none over seven inches long. On their backs and their gleaming bellies are spines as sharp as needles which cause most other fishes to avoid them.

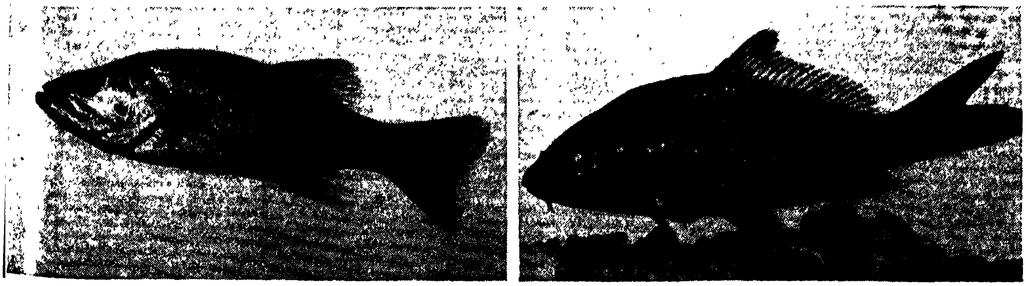
Even these weapons are not an invariable safeguard against the pike. It is on record that a stickleback in an aquarium dined by nibbling at a pike's tail; but hunger-driven pike will banquet on sticklebacks. Still, the spiny defense is usually strong enough, and sticklebacks thrive in millions in many places.

The male makes a beautiful nest in the water and leads a female to it. Sometimes several females lay their eggs in one nest. Then the male takes charge and watches over the eggs with furious affection until they are hatched, charging at any trespasser.

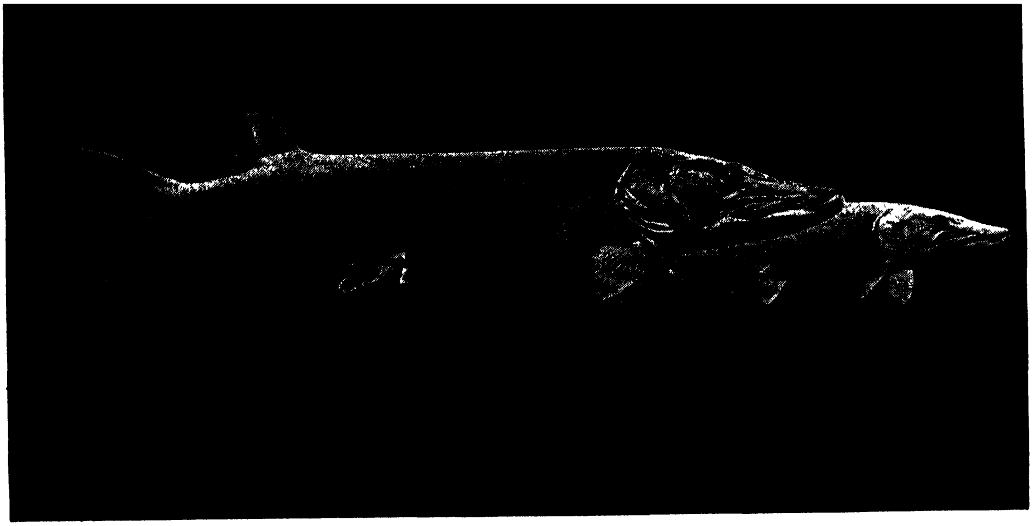
Now let us turn to the great carp, or minnow, family. About 225 species live in North American waters. Most of the species are of small or moderate size.

The true carp was brought to western Europe from China and other parts of Asia. Later it was introduced into American ponds and lakes. Though it thrives, it is not much prized as a food fish, for its flavor is not of the best.

Carp are intelligent, as fish intelligence goes, and do not take a hook readily. Their indifference to human wiles arises partly from the fact that they live largely on vegetation, but they eat worms, small fishes and other tiny animal life. Three children,



Left, the large-mouthed black bass, a game fighter; right, the carp, lazily indifferent to bait and hook.



A close relative of the common pikes, the large muskellunge, found in the Great Lakes region. The name, spelled in a variety of ways, is an Ojibway Indian word meaning "great pike." While the muskellunge prefers the cold of deep lakes, it is sometimes found in streams. It is just as greedy as other pikes, and usually dines on smaller fish.

friends of the writer, put ten thousand tadpoles into a pond where about a hundred golden carp lived, and within a week not a tadpole remained. The goldfish had eaten them.

Yes, the goldfish are carp, the fairest of their tribe, but still carp. How they originally came by their exquisite coloring no one knows. We believe them to have been developed by patient human selection, century after century, in China and Japan, from a small dull-colored Oriental species. In aquariums you can see some of these brilliant fishes, which are highly prized. Some have long drooping tails that hang like plumes. Others have eyes on the end of knobs projecting from their heads. Many strange combinations of red, silver and black are seen. Carp eat well and exhaust little energy, so, like tortoises and turtles, they should live long. And they do. It is said that the great carp still swimming in the lake among the country cottages of Marie Antoinette at Versailles were put there by Marie Antoinette herself. It is believed that this fish may live to be two hundred years old.

Other members of the carp family are the barbel; the gudgeon, which is really a lesser species of barbel; the pretty silvery roach; the rudd, which closely resembles it; the chub, which eats not only frogs, but also the precious young of trout and salmon; the brilliant little dace; the abounding minnow; the tench, which has been introduced into American waters; bream; bleak; stone loach; and groundling, or spiny loach. All these are carp.

To many of the carp, much beauty is given. The bleak, with his shimmering scales as bright as mercury, used to be caught for a strange purpose. Men took off his scales and converted these gleaming morsels into

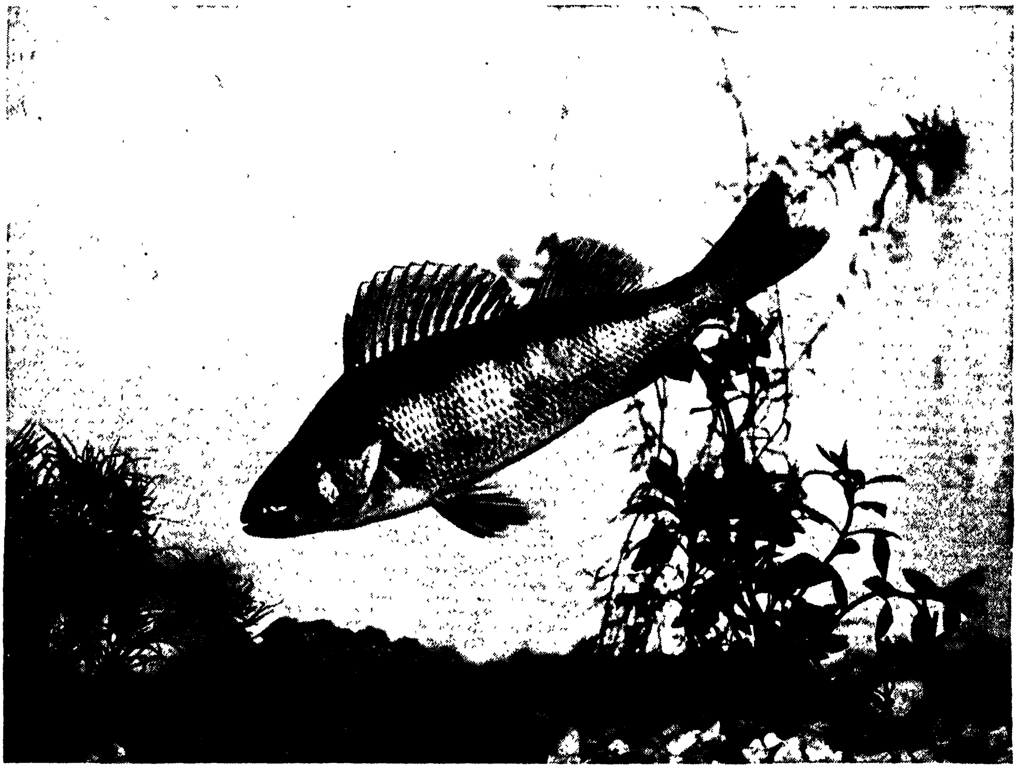
A calico bass, akin to sunfishes, well named for the mottled coloring that gleams through its scales.

Thick, outthrust lips mark the common sucker, whose many tiny bones make eating its flesh hazardous.

a covering for glass beads that were sold as imitation pearls. Herring scales served a similar end. Fish-skin pearls have become less important since men have learned how to grow pearls in oysters.

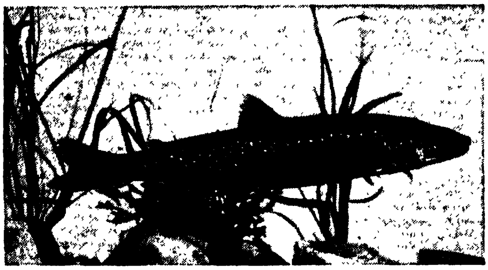
The tiniest of all the carp is the minnow, the commonest, gayest, jolliest of all our fishes of inland waters. Insignificant as the minnows are in size, they are of great importance as the food of other fish. A little mother minnow in her prime lays a thousand eggs a year; hence the enormous numbers. Yet, common as they are, they baffle our study in one important particular: they can change color as rapidly as a chameleon—blue, black, purple shades, dusky gold. These changes do not seem to come in order to match surroundings, but with varying emotions—with appetite, with joy at the sight of food, and sometimes, as it seems, for the mere delight of mocking the rainbow. Some of our members of this family are the squawfish, which is really a kind of minnow in spite of the fact that it is sometimes four feet long. It is common beyond the Rocky Mountains; there are several species of chub; and the western fish known as the white salmon, though it is not a salmon at all. The fallfish is one of the largest of the minnows and is found in the clear swift streams of the East.

The sucker family is another large group of small-mouthed fishes almost entirely confined to North America. They seldom take the hook, and are usually caught in seines, or nets. Some of the family are the buffalo fish, with several species, common in the interior; the lake carp (which is not a carp) found in the lakes drained by the St. Lawrence; the blackhorse of the Mississippi Valley; the redhorse, which is also found in Atlantic waters, and many others called by different names. Dozens of species are caught, but their food value is lessened by the presence of many tiny bones.

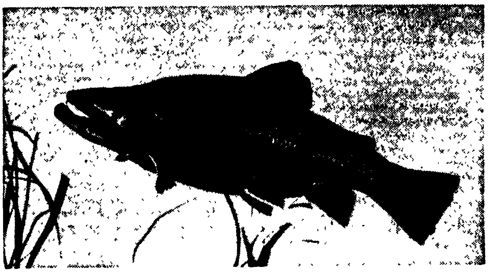


From above the water, the yellow perch is hard to see, for the stripes blur its outline against plants.

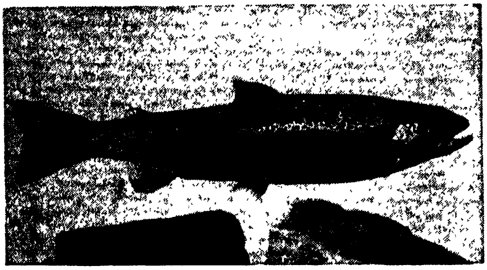
We come now to a grim native of our waters, the pike, found in the northern waters of three continents. It is dreaded by all other forms of life. The pike reaches four or five feet in length, with a weight of



Lake trout, or namaycush, a large trout of North America found from New Brunswick to Alaska.



The fisherman's joy, brook trout, a valiant fighter and, once caught, a delicious food fish.



A rainbow trout—the shimmering iridescence of this beautiful fish rivals the colors of its namesake.

from seventy to one hundred pounds, according to legend, but certainly fifty pounds.

With its weight are associated great power, huge teeth in the lower jaw, and others in the upper part of the mouth that curve backward to the throat, so admitting prey but rendering it impossible for them to escape. This produces results like those we see when two snakes meet mouth to mouth. Some fishermen found two pike of practically equal size engaged in a deadly grapple. One was swallowing the other alive!

Lurking in the shade, looking like a submerged log, the pike resembles the crocodile. When it makes its dart there is no escape. The prey may be its own young; it may be a rat, a water hen, a duck, a dog, a young salmon going seaward. One was seen to seize first a wild duck, then a wood pigeon, which fell into the water from shots from a hunter's gun.

Besides the common pike we have several other fishes closely related. The largest is the muskellunge (the name is spelled in more than a half dozen ways), found in the Great Lakes region. Sometimes it reaches a length of eight feet and often weighs a good deal more than a hundred pounds. It is a good fighter. It prefers cold lakes, but is sometimes found in streams. Like the pike and its smaller cousins the pickerels, the muskellunge greedily eats smaller fish.

Now we come to the salmon family, which is not very large. It includes the whitefish, the salmon and the trout. Moreover, we must divide the salmon. A European knows only the Atlantic salmon *(Salmo salar)*, but in America the Pacific salmon *(Oncorhynchus)* is even more important than the Atlantic. We shall speak of them in a moment.

The whitefish are among the most important American fresh-water fish. There are nearly twenty species, but the common whitefish of the Great Lakes region is the most important. It lives in deep water, but comes to the shallows to spawn. A female may lay 75,000 eggs, but many other fish eat the eggs. In order to keep up the numbers the governments of Canada and of the United States distribute millions of young whitefish every year. Several other species are important, and also the so-called lake herring, or cisco, should be mentioned. Its habits are much the same as its larger relative, though it is much smaller.

Both the Atlantic and the Pacific salmon spend a large part of their lives in the sea, and come up the rivers chiefly to spawn. They are called anadromous fish, from the Greek word that means "ascending." It is commonly believed that they return to the same water they were hatched in, but this is not proved.

Let us first speak of the Atlantic salmon. This fish was much prized by the Roman conquerors of Gaul and Britain two thousand years ago. The Normans valued them highly, and when John Cabot came to explore the new continent he was pleased to recognize his old friends in the waters of Newfoundland. He found that the Indians had learned to spear them as they ascended the rivers. How far north they go we do not know. They are found in all northern European waters, in Greenland and Labrador. Once they were more common than now, and we are told that long ago in Scotland and also in Connecticut servants demanded that they should not be required to eat salmon more than twice a week. In these days fresh salmon is a luxury.

Twice a year, in spring and in fall, salmon leave the sea and make their way up the rivers. Soon after the fish enters the river the silvery color seems to tarnish. The lower jaw of the male grows and grows, until a formidable hook-like process is established in front. The fierce-seeming hook is not a weapon of offense, though the males battle ferociously for their mates, and death sometimes results when a greater salmon fights a smaller. That beak is not bone, but cartilage.

Up and up the stream goes the salmon. Its yearly stay in the river may amount to four or five months, and it was long believed that in all that time the salmon took no food! We were told that the reason salmon were caught with artificial flies and other baits was because the fish were curious.

Naturalists have come to doubt this story. Some believe that in America, at least, the salmon that enter the rivers in the spring come in search of food and perhaps return to the sea. When they again enter the rivers in the fall they do not seem to eat.

Falls and dams do not deter the salmon. So long as there are points in the ascent not more than six feet apart he will get up, leap by leap. Of course salmon make mistakes and sometimes jump out on to the bank. At last the head of the stream is reached, and there the final battles are fought between the males. The females lay their eggs in hollows wriggled out by themselves in the gravel; then all turn their heads downstream and float out to sea, gaunt specters of their earlier selves and worth no man's while to catch. In the ocean their feasting will be renewed, their fat and splendor restored, and in due time they will make another journey inland.

Whitefish, one of the most important food fishes in North America. Government hatcheries distribute millions of young every year. It spends most of its life in deep water, but comes in to the shallows to spawn.

The eggs hatch in from thirty days of mild temperature to five months in cold weather. The young stay for their first two years in the river, but at the end of that time they drop downstream in millions, grow great and strong, then return from the sea. There are salmon, however, that do not go to sea. The sebago, or landlocked salmon, first found in Maine, and the ouananiche of Canada are true salmon that live all their lives in fresh water. Some students of fishes deny that they are really separate species, so much are they like the Atlantic salmon. Anglers say that the ouananiche is the gamest of all fish, fighting furiously to the end.

The story of the Pacific salmon is not quite the same. Like the Atlantic salmon, its ascends the rivers, leaping falls if necessary; the males fight; the nest is dug in the gravel and the eggs, covered in, are left to hatch; but the parents never return to the sea alive, and the young do not remain in the river.

Five species are found in American waters and another in Japan. The chinook, or quinnat, which sometimes weigh a hundred pounds, is most valued, the blueback, or sockeye, is next; but the humpback, the silver and the dog salmon are also taken in considerable quantities. Only a small part of the catch is eaten fresh. From Alaska southward to California are many canneries that pack the fish and send it all over the world.

A THOUSAND-MILE SWIM TO THE CHILL HEADWATERS OF STREAMS

The habits of the chinook have been carefully studied. As they sometimes must travel a thousand miles to the headwaters of the streams they frequent, they enter the rivers in early spring and swim leisurely upward. They will not spawn until the temperature of the water is about fifty-four degrees or lower. If the water is too warm when they arrive, they loaf until the temperature falls. Finally a hole is dug in the gravel, the eggs are deposited during several days, and then are covered. When spawning is completed, the old fish die and float downstream, furnishing food for birds and animals.

Depending somewhat upon the temperature of the water, the eggs hatch in from four to six months, and as the young grow they make their way downstream into the ocean or the bays and sounds.

Many different American fishes are called trout. Though all, or nearly all, belong to

Fighting a rushing torrent, a humpback salmon leaps a low falls in Litnik Stream, on Afognak Island, Alaska.

This part of the Pacific salmon's life-story is a desperate struggle, all for the sake of the next generation. When at last it reaches the headwaters of the stream, and the eggs are left to hatch, it will perish.

the salmon family, we have at least three genera and many species. Many of their habits are like those of the salmon, and a few go to sea, though most of them spend their lives in fresh water.

Strange to say, those most closely allied to the Atlantic salmon *(Salmo salar)* are found in lakes and streams in the western half of the continent. There are twenty or more species, such as the steelhead, the rainbow, the salmon, the golden, and many others.

In the Great Lakes are found two large trout of a different genus. The Great Lakes trout has been known to weigh 125 pounds. It is usually taken in nets, and the value is considerable. Another form, the siscowet, is less liked.

Most of the eastern trout, as well as some European trout, are chars, belonging to the genus *Salvelinus*. The most famous is the brook, or speckled, trout, beloved of all fishermen. It is one of the most beautiful of fish, and has been introduced into many streams. The Dolly Varden is found only in Pacific waters, and is sometimes called salmon trout. Then there are the blueback of Maine and Quebec, and the sunapee, possibly a variation of the brook trout of Europe. The European brown trout *(Salmo fario)* has become naturalized. The real fisherman feels it unsportsmanlike to take any of these except with an artificial fly. Most eastern streams are much fished and the supply is kept up by artificial hatching.

The eel never fails to fascinate us. It is born over a thousand feet deep in the warm Atlantic, thousands of miles at sea, yet it swims slowly to some riverway, bay or inland pond. Countless millions of the fry ascend the rivers at a time. At the foot of Niagara Falls in spring and early summer hundreds of thousands have been seen crawling over the slippery rocks.

They swim up the streams, they climb with wriggling gait through sluices, they ascend the banks and wriggle their way inland to ponds, pools and ditches and even to wells that they have never seen. For six, seven or ten years the eels grow up in these streams and ponds; then out they go, back by the way they came, over rough ways and smooth, moist ways and dry, to the river, down to the open sea, and then straight out to sea. Both European and American eels seem to spawn south of the Azores. Then they die.

It is estimated that a large eel will lay at least ten million eggs. From those that hatch come creatures entirely unlike eels. They were long mistaken for a sort of ribbon fish, for they do not look like eels. The head is small and tubular, with projecting teeth, but the body is flattened.

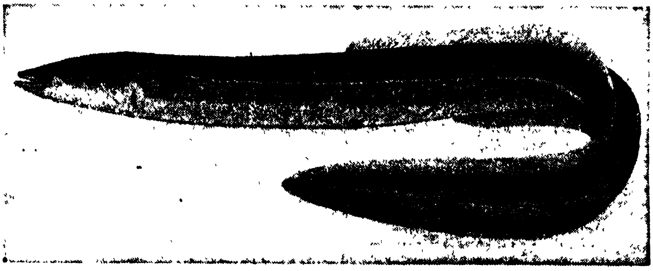
As soon as they are able to travel, the cousins part, the American turning west and making for the New World; the others turning east and beginning a long voyage to Europe. At first they grow readily in the flattened shape, but feeding brings a change. They alter as remarkably as a tadpole. The head does not grow, but the body diminishes to match its size, and takes on a cylindrical shape.

When the change begins in the deep sea the little eels are three inches or more long, but they fast while the transformation is in progress, and measure but two inches on entering the rivers, weighing about 1,500 to the pound. The young eels take a year to navigate from the depths beyond the Azores to the rivers they will ascend.

Though eels are valuable for food, fishermen hate them because they eat so many other fish.

These are not all of the fishes of our rivers and lakes, but they are the most important. As we have several hundred species of fishes that are good for food, you can see that we can not describe them all without using a whole volume. The other fishes that live in the sea but visit rivers are described in another chapter.

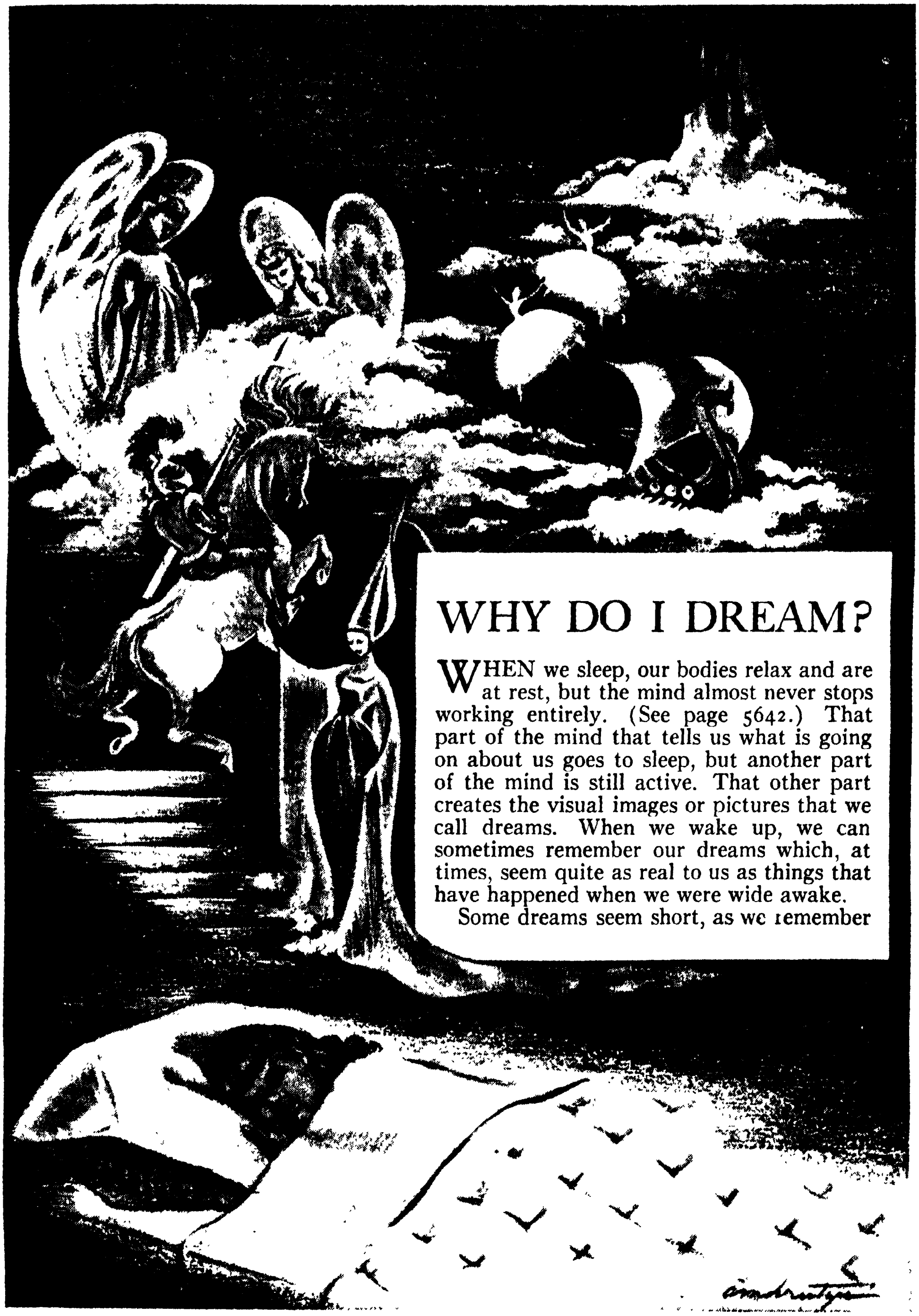
THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5772.



The eels that wriggle up eastern waters in the spring and early summer were born in the warm Atlantic Ocean, thousands of miles away.

There they parted from their European relatives, for all appear to spawn in the sea south of the Azores.

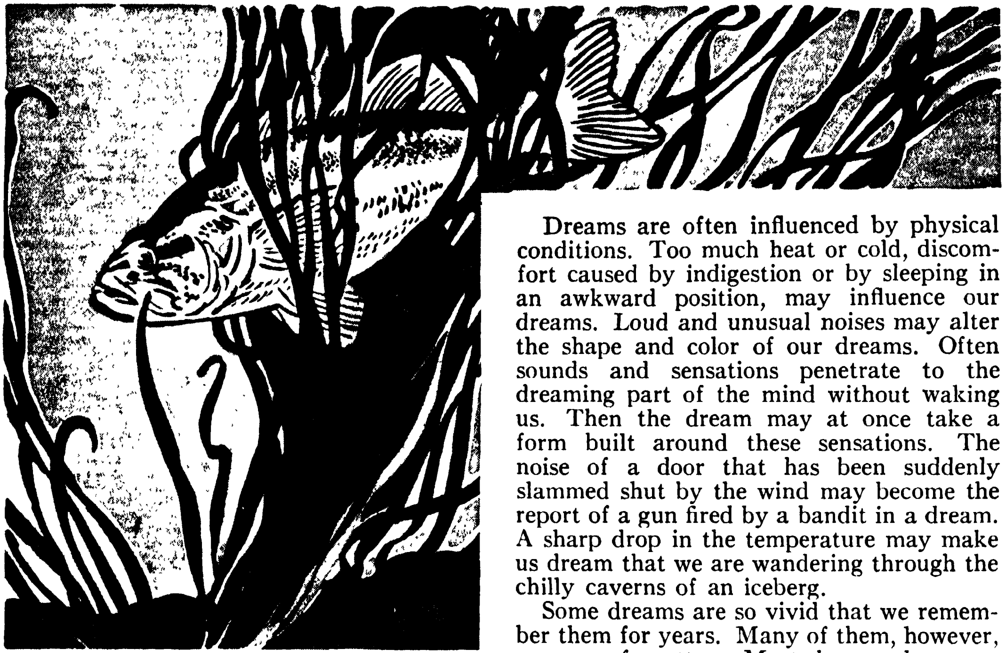
U. S. Fish and Wildlife Service



WHY DO I DREAM?

WHEN we sleep, our bodies relax and are at rest, but the mind almost never stops working entirely. (See page 5642.) That part of the mind that tells us what is going on about us goes to sleep, but another part of the mind is still active. That other part creates the visual images or pictures that we call dreams. When we wake up, we can sometimes remember our dreams which, at times, seem quite as real to us as things that have happened when we were wide awake.

Some dreams seem short, as we remember



them afterward, and some seem to go on and on. There have even been cases where the story of a dream is continued from night to night, almost like a continued story in a magazine. Sometimes, when you dream, you yourself seem to be acting out the main part of the dream, or you may be just a spectator of what is going on. Your dreams may be funny, and you may wake up laughing. Or they may be sad or terrifying. Whatever kind of dreams you have, it is not likely that you often remember everything that happens in them.

There is a great deal that we do not yet understand about dreams. Many people think that our dreams do not mean anything at all. Many modern psychologists believe that, if we could understand our dreams, they could tell us much about our feelings and our attitudes toward life. The character of our dreams usually changes as we go on through life. Grown-up people's dreams are usually much more complex than those of children. Children often dream of doing things that they would like to be able to do when they are awake. They often dream, too, as do grownups, of things that have happened. In the dream, however, the actual happenings are almost never shown exactly as they happened, and they are often much more interesting than real life.

Dreams are often influenced by physical conditions. Too much heat or cold, discomfort caused by indigestion or by sleeping in an awkward position, may influence our dreams. Loud and unusual noises may alter the shape and color of our dreams. Often sounds and sensations penetrate to the dreaming part of the mind without waking us. Then the dream may at once take a form built around these sensations. The noise of a door that has been suddenly slammed shut by the wind may become the report of a gun fired by a bandit in a dream. A sharp drop in the temperature may make us dream that we are wandering through the chilly caverns of an iceberg.

Some dreams are so vivid that we remember them for years. Many of them, however, are soon forgotten. Most dreams, however, are probably never remembered at all, and we do not even know that we have dreamed them.

DO FISHES CLOSE THEIR EYES AND SLEEP UNDER WATER?

Fishes sleep, but they can not close their eyes, because they have no eyelids. They probably do not sleep very soundly, but when they are lying very still in the water they are undoubtedly resting in much the same way as we do when we sleep. If you look at the snakes in the zoo, you will notice that they always seem to have their eyes wide open, with a fixed stare. And yet sometimes they are fast asleep, even though their eyes are open. Snakes, like fish, have no proper eyelids to drop over their eyes.

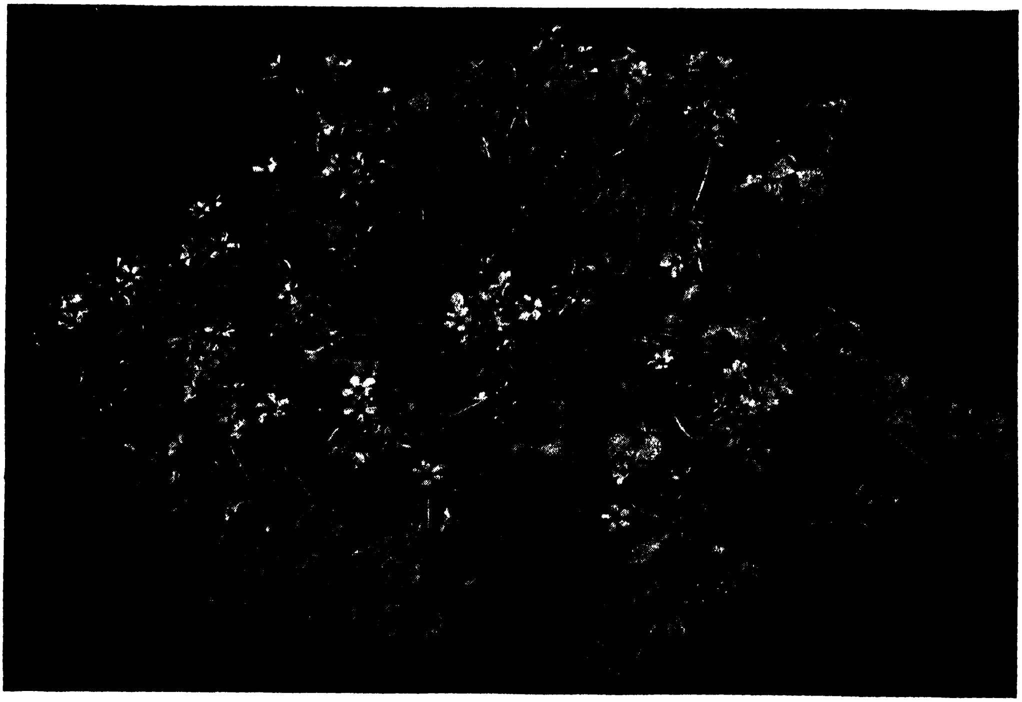
DOES A PLANT GO TO SLEEP?

The word sleep, as we usually use it, means a condition in which consciousness of the outer world is lost. A man who sleeps does not see or hear what is going on around him.

In this meaning of the word sleep, plants do not sleep. They have no sense of sight or hearing to begin with. Yet, in the sense in which sleep is a periodical rest from activity, plants may be said to sleep in vary-

HOW A PLANT GOES TO SLEEP

A pot of oxalis asleep. Leaves and blossoms are folded. Flowers, like all living things, must sleep sometimes.



Brooklyn Botanic Garden

The same pot of oxalis awake, spreading its leaves and flowers open to the air and sunlight.

ing degrees at various times.

In winter, many plants live a life so much less active than their summer life that they may be said to sleep. A green plant that has shed its leaves may, in more than the poet's sense, be said to be asleep. Without the green leaves it can not make starch, or sugar, or woody fiber, or nectar, or pollen, or buds or flowers. It is not dead, but it is not working and making living tissues.

Plants also rest from work—they sleep—during the night when the sun is not shining. When the sun shines, they are busy breaking up carbon dioxide and building the carbon into sugar and starch and other substances. When the sun ceases to shine, all that wonderful chemical work ceases, too.

Some flowers may also be said to sleep when they close their petals, but this kind of sleep is not so real as the other kinds we have mentioned. There are some flowers that open their petals at night—at the very time when they are doing little or no work. These flowers are probably pollinated by night-flying insects, drawn to them by scent and not color. Many night-blooming flowers are white.

In other cases, flowers close their petals and curl up their leaves to retain moisture or to escape the sun's heat, but this is not sleep.

Sleep is rest, and when plants cease, or almost cease, to work, then only can we say that they sleep. Trees, too, which are also plants, may be said to go to sleep in the same sense. Those that lose their leaves in the autumn rest through the winter.

WHERE AM I IN MY SLEEP?

When you sleep, your body stays exactly where you were when you feel asleep—right in your own bed. Yet in your dreams you may be a great traveler. You may climb a high mountain to visit the den of a giant on the summit. You may travel far away—even to the moon—and come across strange people and animals never before seen by human beings. Or you may find yourself riding down the street like a hero, on the beautiful black pony you have wanted so long, with all your friends watching and cheering. All these fine travels and adventures take place because a part of your mind has not gone to sleep. It goes on working. We call this the unconscious, or subconscious, mind. The conscious mind observes, reasons, solves problems and generally serves us by day; at night when we sleep it sleeps too. We are then unaware of what is going on around us in the room. The unconscious, without our being aware of it, stores up impressions, desires and memories. During our sleep it may become active, so that we live over again scenes from our past life; or we have our wishes come true; or odd bits and pieces of information come together forming queer dreams.

Do you ever daydream? Here, too, the unconscious mind is at work. Very few people, when they are daydreaming, become completely unconscious of their surroundings, as in sleep. But if the daydreams are very vivid, the actual surroundings become much less real than they usually are. You may be gazing out of your window, seeing the street, the trees and the people, while your unconscious mind is showing you pictures or fantasies of something entirely different.

(A few people, of course, walk in their sleep, but this is not normal in sleep.)

WHAT HAPPENS WHEN WE GET TIRED?

All kinds of things happen to us when we get tired, and many of these are very complicated. Sometimes we get tired because of poisons that have been produced in our bodies as the result of physical activity. We may become tired, also, when we have been too long a time in the sun or in the heat. Our muscles may feel tired because our bodies can not get rid of the poisonous materials that have accumulated in our bodies. But sleep will put this right, and usually after a night's good sleep we wake refreshed and rested.

Sometimes we say that we are nervously tired, when our bodies may not be tired at all. If we have been under a great strain, or if we have been studying too hard, the sense of fatigue is just as great as though we had been running races.

We should eat only a little, if at all, when we are very tired. The best thing for tiredness is sleep. Young people who are still growing often need ten hours' sleep out of the twenty-four hours of the day.

We may take water when we are tired, or lemonade or oranges. These things, in passing through the body, help to carry all sorts of poisons away. Generally, the people who sleep best are those who work hard. Natural fatigue produces in our bodies the very thing that gives us perfect and natural sleep.

WHAT HAPPENS WHEN MY FOOT GOES TO SLEEP?

Our muscles, those bands of flesh that move the different parts of our bodies, can move only when directed to do so by our motor nerves. These nerves may be roughly described as telegraph wires between our nerve centers and our muscles. Before the order is sent from the nerve center along the motor nerve, directing the muscle to move, the nerve center has to receive a message from another and quite different nerve called the sensory nerve.

From the brain, or from the spinal cord (the big nerve that runs up the backbone), motor and sensory nerves are connected to every part of the body. If a motor nerve is cut, we lose all control of the part of the body it serves, but sensation remains. We

can still *feel* in that part of the body. If a sensory nerve is cut, we lose sensation in the part that it serves, but retain the power of movement. If both are cut, we lose both sensation and the power to move.

Fortunately, serious damage to a nerve does not often occur, but we do sometimes experience pressure on a nerve. If you sit on a chair so that a sharp edge presses against the nerves of your leg, you may find that your foot "goes to sleep." The pressure has affected the nerves serving your foot, and by compressing their fibers has made them incapable of transmitting impulses. When you try to get up, you can not feel your foot because the sensory nerve has been pressed too hard by the edge of the chair. You can not direct the foot to act because the motor nerve has been affected, too. The foot is numb. Gradually, the nerves recover after the pressure is removed, and you feel your foot tingling with a sensation that we call "pins and needles."

WHY MUST A BABY HAVE MORE SLEEP THAN A GROWNUP?

The body of a little baby has a great deal of growing to do before it becomes as large as that of a grownup. Much of this growing is done during sleep. When a baby is very young, it does little but eat and sleep. While it is awake, it eats the food that it needs in order to grow. During sleep it uses the food to make bones and muscles and skin and blood.

Grown-up people sleep because they need a period of rest during which their bodies can make up for the wear and tear of the activities of the daytime. But the body of a child has much more to do than this—the body needs actually to be built. As we have seen, much of this is done during sleep.

DO ANIMALS HAVE DREAMS AS WE DO?

Animals probably do have dreams. If you have ever watched a sleeping dog, you may have seen him, in deep sleep, begin to twitch and to make little barking noises. Sometimes a dog's legs will move in his sleep, much as though he were trying to run. Perhaps he is dreaming that he is chasing a rabbit across a field.

Just as animals have ways of showing their feelings when they are awake, so they show these same kinds of feelings when they are asleep. This is true also of babies and young children, and so we believe that they dream just as grownups do.

WHY DO TEA AND COFFEE KEEP US AWAKE?

Both tea and coffee contain stimulating substances that excite the nervous system. In tea the substance is called theine, and in coffee, caffeine. Theine and caffeine are chemically almost the same, and their effects are practically the same.

These substances stimulate the brain and prevent a person from becoming drowsy. Their effect varies with different persons, but probably in most cases strong tea or coffee tends to hinder sleep.

WHAT MAKES ME WAKE UP IN THE MORNING?

During the first part of the night we sleep very soundly, but as the hours pass we sleep less and less deeply. When a person has had nearly enough sleep, he will be wakened by a noise that he would not have noticed a few hours before, or by the morning light, or even by his own movements in bed. If we lived out-of-doors, as men did long ago, and as birds still do, the light of day would wake us up. Different people need different amounts of sleep to keep them well and happy. When you have had about as much sleep as your body requires, you can then be wakened very easily.

WHY, WHEN I WAKE, DO I SEEM TO HAVE JUST GONE TO SLEEP?

When we are asleep and unaware of what is going on around us, we have no knowledge of the passing of time, and time does not exist for us. When we wake up, it may seem that time and life are going on from the last moment we remember before we went to sleep. Yet, with some people, the body might be said to have a sense of time. If such a person is awakened suddenly while it is still dark, he can often guess quite accurately what time it is. Some people also seem to be able to "set" their minds to awaken at a certain time.

WHAT HAPPENS WHEN ONE SNORES?

When a person falls asleep lying on his back, and when he begins to breathe deeply through his open mouth, he is quite likely to snore. The sound is caused by the vibration of the soft palate and of the uvula, the fleshy, hanging part of the soft palate. Snoring is harmless to the snorer, though it is often extremely annoying to the people who have to listen to it.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5739.

The Bettmann Archive

The beauty and charm of Mary Queen of Scots and the tragic story of her reign have made her one of history's most famous women. Here we see Mary with her infant son, the future King James I of England.

KINGS and QUEENS of SCOTLAND

LITTLE is known about Scotland's earliest rulers. Many legends have come down to us from olden times, but we do not know where legend ends and history begins. The most famous of the old legends tells of a Greek warrior named Gathelus. With a band of followers Gathelus arrived in Egypt a few years before the great Exodus that is described in the Old Testament. He fought with such courage that the Pharaoh appointed him commander-in-chief of the Egyptian army and allowed him to marry an Egyptian princess, Scota. When the Pharaoh's army was destroyed in the Red Sea, Gathelus and Scota fled to Europe; and finally to Ireland. Note that the original Scotia was Ireland named after this Egyptian princess.

There were in these days living in the northern part of the island of Britain some tribes of ancient origin, called Caledonians; and the land was called Caledonia. There were some other tribes there, called Britons. In time the Caledonians came to be called Picts and they became the strong ones.

The descendants of Scota grew very numerous in Ireland, and at the beginning of the sixth century bands of these Scots moved over into Caledonia and made their homes there, in spite of all the Picts could do to keep them out.

We know that the Picts and the Scots fought fiercely among themselves, marching into battle with their troops of bagpipers playing to give them courage. (That is what some scholars think. Others say the bagpipes were not common in Caledonia until later.) The Picts and the Scots were strong, fearless men, and many of the kings who ruled Scotland in later years inherited their strength and boldness.

In 860 A.D. we know for certain that Kenneth MacAlpine was ruler of the tribe of Scots. Through his mother he was a Pict, and so he held sovereignty over both Picts and Scots in quite an extensive territory. His dominion, called Scot-land, included all the land north of the Firth of Forth. Later the land between the Firth of Forth and the river Tweed was taken from the English and added to Scotland. The capital was Scone.

After Kenneth MacAlpine came a number of kings whose chief work was fighting. They fought the English, the Norsemen and the Britons. And often they had to fight their own chieftains who were independent and proud and jealous of their rights. Then Duncan came to the throne, the same gentle Duncan whom Shakespeare shows us in his tragedy MACBETH. With Duncan the gaps in our knowledge end; and the colorful historical pageant of Scottish kings and queens really begins.

Duncan's reign was sad and trying. In Shakespeare's play, Duncan's eyes fill with tears as he recalls the "plenteous joys" of his life: but history shows few, if any, joys in Duncan's life. The Scots army was defeated by the Northumbrians (English) and by the Norsemen. Civil wars followed, and Duncan was killed in a fight in 1040 by one of his own generals, Macbeth.

Shakespeare painted Macbeth as a shockingly ambitious man who murdered his king to get the throne. As a matter of fact, Macbeth had a claim to the throne not only in his own right but also through his marriage to Gruoch, the granddaughter of an earlier king. After Duncan's death, Macbeth seized the throne; and Duncan's son and heir, Malcolm, fled to England.

HOW MACBETH RULED AS A WISE KING UNTIL MADNESS BROUGHT HIS RUIN

Macbeth and Gruoch ruled wisely. They made laws for the benefit of the common people and established churches throughout Scotland. The people called Macbeth "the red one, fair, yellow, and tall." Soon, however, the violent deeds of his youth began to affect his mind. Those about him whispered, "He is full of heavy thoughts and woe. The King trusts every man to do such cruelties to him as he did to others." Macduff, one of his generals, slipped away to England to tell Malcolm about Macbeth's madness, and to advise Malcolm to prepare himself to fight for the throne, for the time had come to assert his rights. Hastily gathering together an army, Malcolm invaded Scotland, and Macbeth was slain.

Malcolm, nicknamed Canmore, or "big head," ascended the throne in 1057. Eleven years later he married an English princess, Margaret, sister of Edgar Atheling, the Saxon who claimed the throne of England. This was in 1068, two years after William the Conqueror had taken England for himself.

Malcolm fought more than one battle against the Normans, to try and get the English throne for his brother-in-law; but he was no match for the Normans. Malcolm was killed in battle in 1093.

WISE AND GOOD QUEEN MARGARET WHO DID MUCH TO HELP THE POOR

For three years Margaret served as regent for her son, who was too young to rule. A noble and devout woman, she brought about many reforms. Through her foresight foreign trade was encouraged. Some say that she introduced the clan plaids into Scotland. Under her influence many injustices were abolished, and many acts of charity performed. Every day she went among the poor and did what she could to ease their misery. Because of her noble soul, later generations called Queen Margaret Saint Margaret.

In 1096 Malcolm's son, Edgar, succeeded to the throne. A second son, Alexander I, followed Edgar in 1106, and a third son, David I, became king in 1124. Although Edgar was a kind ruler, people remember him only because he presented a camel to a brother monarch. Alexander inherited many of the traits of Queen Margaret. An old manuscript describes him as "brave, warlike, ambitious and somewhat austere . . . a lettered and godly man, zealous in building churches, in searching for relics of saints . . . and so devoted to the poor that he seemed to delight in nothing so much as supporting them, washing them, nourishing them, and clothing them."

But David's deeds were more distinguished than those of his brothers. David lived from about 1080 to 1153. The early years of his reign were troubled. He laid claim to the English throne in the name of his wife (grandniece of Henry I) and marched against the English king, Stephen. But the English defeated his armies at Northallerton. After this David turned his attention to the internal affairs of his kingdom. Under his rule the people felt a new security. He abolished hanging for minor crimes. He founded many churches and abbeys. In fact, he gave so much money to the Church that he made the Crown poor. He encouraged education and tried to promote in Scotland the more advanced civilization of England. The abbot chosen to record David's official biography wrote, "His memory is blessed through all generations."

David's grandson, Malcolm IV (1141–65) succeeded to the crown in 1153, but his reign was undistinguished. William (1143–1214), "the friend of God and the Lion of Justice," was crowned two weeks after his brother Malcolm's death, in 1165. Malcolm had ceded Scottish territory to the English king, and William the Lion set out to recover it. On the battlefield he was surrounded by the enemy and taken prisoner. Only by allowing the English certain castles in Scotland and recognizing the king of England as the overlord of the whole kingdom of Scotland did William regain his freedom. Fifteen years later Richard the Lion-Hearted of England, for a sum of money restored the independence of Scotland. Then, for one hundred years, the wars with England ceased.

The Saxon Margaret arriving in Scotland for her marriage to King Malcolm.

A day after William died (in 1214), his son was crowned Alexander II (1198–1249). Thirty-five years later he was, in turn, succeeded by his son, Alexander III (1241–86), a lad only eight years old. Many of the people cried, "Woe unto the kingdom where the king is a child!" During the thirty-six years of his rule, Alexander disproved this old saying. He defied the English king's demand for homage from Scotland. He crushed an invasion of Norsemen and forced their king, Haakon, to cede the western Isles and the Isle of Man to Scotland.

At this time, the Scots claim, the thistle became their national emblem. It came about in this way. The Norsemen planned a night attack on Alexander's army. As they approached the Scottish camp, one of their numbers stepped on a thistle with his bare feet. His cries warned the Scots, and they drove the invaders into the sea.

The good deeds of King David I, whose reign brought order to Scotland.

When the peace treaty was signed, Alexander arranged for his daughter, Margaret, to marry Haakon's son, Erik. Alexander's two sons died within the next year. This left his only grandchild, a girl, daughter of Margaret and Erik, as heir to the throne of Scotland. No woman had yet mounted this throne in her own right. Many in Scotland opposed breaking this tradition. Thus some looked upon the Maid of Norway as Alexander's heir, others debated who the next king would be. Then, on a wild, wet night, King Alexander fell from his horse and broke his neck. Margaret was declared queen of Scots, and guardians were appointed to care for the eight-year-old ruler. But the unfortunate girl never reached Scotland. Her ship sailed to the islands of Orkney where she became violently and mysteriously ill. She was taken ashore to die.

Many barons now claimed the throne. John Balliol and Robert Bruce, descendants of King David, were the chief competitors. Edward I of England determined to choose one or the other to rule Scotland. Bruce refused to admit that the king of England was overlord of Scotland. Balliol was willing to accept Edward as overlord, so Edward chose Balliol. England was again the master of Scotland. King John Balliol could not long endure this overlordship. He defied Edward and found himself a prisoner in the Tower of London.

JOHN BALLIOL, WHO GAINED AND LOST THE THRONE THROUGH ENGLISH POWER

For nine years Edward controlled Scotland by English officers whom he placed in the land. An opposing Scottish party, led by Sir William Wallace, tried to throw out the English. For this attempt, though it failed, Wallace has been remembered as one of Scotland's greatest heroes. He was captured by the English and tortured to death. But his efforts inspired others to act. Among his men was one destined to free Scotland. This young man, Robert Bruce (1274–1329), a grandson of the Robert Bruce mentioned above, fought bitterly against the English. He hoped to free his country and rule as its king. At the same time he was troubled by the claims to the throne of Red Comyn, a descendant of John Balliol. They made a pact, but Comyn was treacherous and told all its secrets to the English king. Before the high altar in the church of the Grey Friars at Dumfries the two met for the last time. A quarrel broke out, and Bruce stabbed Comyn. This was a sacrilegious act, to kill a man before the altar of God; and Bruce's conscience troubled him sorely for the rest of his life.

Now that he had killed Comyn, Bruce feared the punishment of the law. He could not be safe unless he placed himself above the law. In that very same year, 1306, Robert, the Bruce, had himself crowned king of Scotland. (The head of a family, or clan, in Scotland and Ireland had "the" in front of his family name—Robert, the Bruce.)

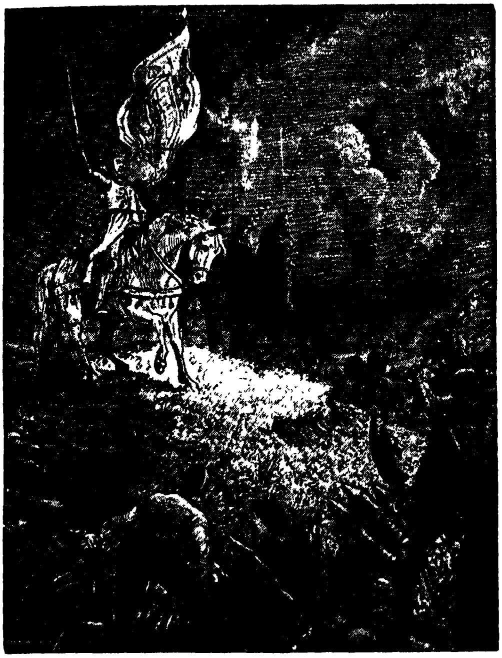
Still the war with England continued. A famous story is told about Robert the Bruce at this time. Of course the English were trying to capture him, and more than once he had to flee to the mountains and hide in the caves or in the cottages of loyal followers. One day he lay in a peasant's hut, weary and overcome by a sense of failure and hopelessness. He was almost ready to give up the struggle. While he was gloomily thinking the matter over, counting up all his disappointments, he saw a spider trying to spin a web between two beams. The little spinner swung out from the first beam on a thread, but failed to reach the second beam. She had to make her way back along the thread to the first beam, then try again to swing across. Again she failed. Bruce watched closely now. Three times she failed. Four. Five. Six. Yet she kept on. Robert the Bruce willed her to succeed on the next try. She failed, and on the eighth attempt also. Would she try again? The heart of the fugitive king beat fast with excitement, while the spider made a ninth attempt—and failed.

"If she tries once more—but she will not—but if she does try once more—I'll try once more to win my throne," said the King.

As he watched, the spider swung out for the tenth time, and reached the second beam! She had not only tried again, she had won!

THE GREAT BATTLE OF BANNOCKBURN WHERE SCOTLAND WON HER FREEDOM

Whether or not this story is true, Bruce did keep trying, winning and losing fights, but mostly winning, until he came to the battle that should decide all the fighting. The place of the battle was Bannockburn. The odds were great against the Scots. Robert the Bruce proclaimed that those who were not prepared to conquer or die with him might leave the field. None stirred. He reminded his men that England fought for conquest; Scotland, for freedom. The two forces clashed, and many men on both sides fell. The ravine of Bannockburn was almost choked with the dead. Suddenly, from behind the Scottish line, came a group of shouting men. They were only a few serving men, not soldiers at all. But they made such a frightful clamor that the English, thinking that fresh Scottish troops had come up, fled. An English war correspondent in his report of the battle wrote, "O day of



King Robert Bruce addressing his troops before the great Battle of Bannockburn.

vengeance and misfortune and perdition which tarnished the fame of the English and enriched the Scots with the plunder of the precious stuff of our nation . . ." The Battle of Bannockburn was fought in 1314.

All the Scots rose to acknowledge their king who, after twelve long years, had triumphed. King Robert, however, could not enjoy his victories, for leprosy ravaged his body. He had long wished to go on a pilgrimage to the Holy Land to atone for his crime at Dumfries, but his illness prevented the journey. "I have had so much to do in this life," said the weary King, "and now have been smitten with such sickness that I can not escape. Seeing, therefore, that my body can not achieve my heart's desire, I will send my heart instead of my body." As he lay dying, Robert begged Lord James Douglas to carry his heart to the Holy Land.

On the way Lord James landed in Spain where the Saracens were attacking the Christians. He offered his services to the Spanish and rode into battle against the infidels. The Saracens were winning until Lord James drew forth King Robert's heart. "Pass first," he said, "as thou were wont to do, thou noble heart, and Douglas will follow thee or die!" He hurled the heart against the Saracens and plunged into the thick of the fray after it. With his great sword he hacked his way through the enemy till he reached the noble relic and there was slain; but his charge had routed the Saracens. A Scottish knight found Bruce's heart and bore it home, knowing that the dead Bruce had now fought well against the infidels. Ever after that the Douglas coat-of-arms bore a bleeding heart.

THE FIRST OF THE GREAT LINE OF STEWART, OR STUART, KINGS

King Robert's son, David II (1324–71), ruled after the death of the Bruce. In 1371 he was followed by a grandson of King Robert—Robert the High Steward of Scotland (1316–90). Later, the spelling of Steward was changed to Stewart and to Stuart, and it became the name of a great line of Scottish kings. This first Stewart was a noble lord beloved by all his people. He was described as "a prince of such constancy in promise that he seldom spoke a word which he performed not."

His son inherited the throne. He had been christened John, but he changed his name to Robert because King John of England, King John Balliol of Scotland and King John of France had been such unlucky men. Nevertheless, his own life, as well, was filled with misery.

This Robert—Robert III—lived from about 1340 to 1406. His eldest son was murdered, and his second son, who later became King James I, was imprisoned by the English. These blows killed the unhappy monarch. Realizing that death was near, Robert wrote his own epitaph: "Here lies the worst of kings and the unhappiest of men."

The English held King James I (1394–1437) a prisoner for eighteen years. James's captivity was not a great hardship for him. He was more student than statesman. He had great talent for medicine, theology, lute playing, singing, dancing and writing poetry; and he amused himself in these ways during his long captivity. One day he saw a young girl in the garden below his prison tower. He fell in love with her and wrote a beautiful poem, The Kingis Quair, or King's Book, about her. It contained this stanza:

> Yet still above all this, she had, I wote,
> Beauty enough to make a world to dote!
> Ah! suete, are ye a warldly creature?
> Or Hevinly thing in likeness of nature?
> Or are ye God Cupidis owin princesse?

After James was freed, in 1423, this beautiful woman, Lady Jane Beaufort, became his wife.

HOW JAMES I TRIED TO RESTORE ORDER AND WAS SLAIN BY ONE OF THE NOBLES

On his return to Scotland, James found his country in great disorder and full of lawlessness. He resolved to reform the ills of his land. Great sums of money were needed, so James levied taxes. Many of the nobles opposed his plans and plotted against him. Sir Robert Graham broke into his chambers one night and stabbed the King to death. Graham was hanged for the crime. The people of Scotland never forgave his memory for what he had done. As he died, they shouted, "Robert Graham that killed our King, God give him shame."

James's son, James II (1430-60), tried, when he came of age, to continue the good works of his father; but his enemies did all in their power to thwart his plans. During a siege a cannon exploded near James, and he was killed. His son, James III (1451-88), accomplished nothing. The barons rebelled against him and routed his forces. As he fled from the field, James was thrown from his horse. He escaped to a peasant's hut, but one of the rebels followed him. This unknown man drew his dagger and murdered the King.

Scotland was sorely in need of a strong and righteous leader. The new ruler, James IV (1473–1513), seemed to be just that. He was hailed as the "greatest of all the Stewarts." The people admired his virtues and said of him, "Every man loved the Prince so well that they would in no wise disobey him." James would travel among his people in disguise to see that they were well treated. Although he gave Scotland a powerful navy, James was called "the most peacefully disposed Prince in Europe." Yet he brought disaster upon Scotland. He married Margaret Tudor, daughter of Henry VII. Yet when King Henry VIII declared war with France, King James led an army against his brother-in-law, because of an old friendship between the French and the Scots.

THE TRAGIC BATTLE OF FLODDEN FIELD WHERE JAMES IV ATTACKED THE ENGLISH

With great determination James assembled his men for an attack at Flodden Field. He rode in the thick of the fighting, but all his efforts failed. By morning the English were the only living creatures on the field. About them they saw abandoned Scottish guns, dead Scots and streams running red with blood. James, too, had been slain, and the English captured his body. In memory of that national calamity a mournful dirge was composed and sung by the people of Scotland:

> All the Scots that were 'scaped,
> Were scattered far asunder.
> For all the lords of their lans,
> Were left behind them!
> Breathless they lie,
> Gaping against the moon.
> Their ghosts went away!
> I have never read in tragedy or story,
> At one journey so many nobles slain
> For the defence and love of their sovereign.

The saddened Scots could not rejoice at the next coronation, held in 1513, which they called the Mourning Coronation. The infant James V (1512-42) never throughout his whole life escaped the woeful atmosphere of this event. Trouble with England broke out in James's thirtieth year; and an English triumph at Solway Moss filled James with a great melancholy. He shut himself up in his palace; he would neither eat nor sleep. News was brought to him of the birth of a daughter, but he could not rejoice. This daughter was scarcely eight days old when the King died.

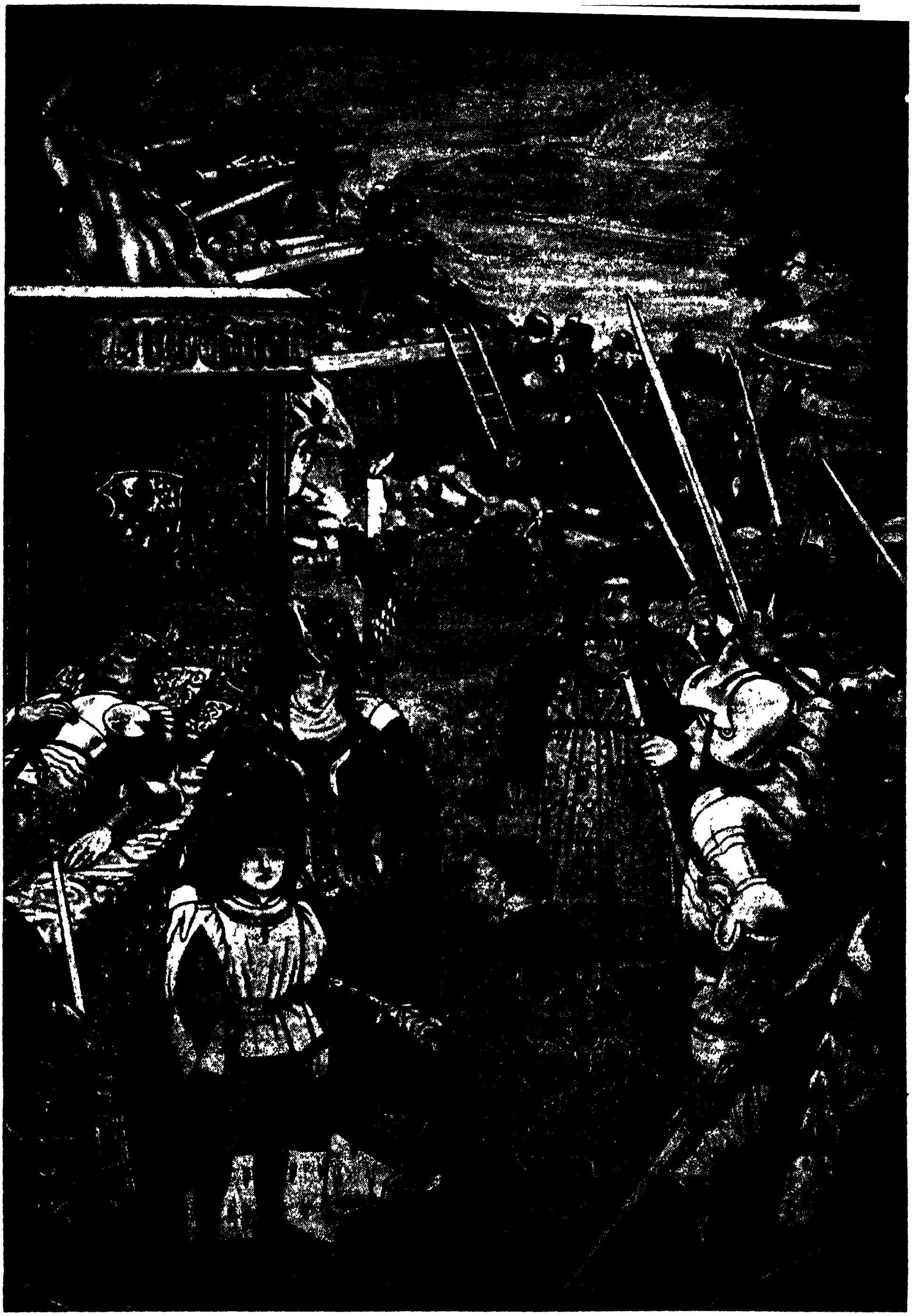
HOW A BABY GIRL OF NINE MONTHS WAS CROWNED AS MARY QUEEN OF SCOTS

James had been married twice, both times to French princesses. His second wife, Mary of Lorraine, of the powerful Guise family, was mother of James's heir, the baby girl, Mary. The official witnesses of Mary's birth were dismayed. "It's but a puir wee lassie," they said. Scotland had had only one queen, the Maid of Norway; she also was a child, and she died before she came of age to rule. When Mary Stewart (or Stuart) was nine months old, she was crowned as Mary Queen of Scots (1542–87).

There were many enemies at home, so when she was six years old the young queen was sent to France for safekeeping, while her mother ruled as regent in Scotland. In France, Mary was never allowed to forget her royal state. She gave audiences, listened to appeals, and, in silence, watched the bickering factions about her. Her advisers, members of her mother's family, the Guises, were training her to be a queen.

When she was sixteen years old, Mary married Francis, the Dauphin of France. When his father, the King, died, she was for about a year the queen of France. The next year both Francis and Mary's mother died. She decided to return home and take her place as the ruler of her people. On a misty, dark day the beautiful Queen landed

JAMES III PRESENTED TO THE NOBLES



When James II was killed in Roxburgh, the Scottish nobles lost heart, but James's widow took the little king, James III, to Roxburgh, and so inspired the nobles that they rose and defeated the English. Here we see the knights and nobles promising the Queen and her little son that they will keep on fighting.

in Scotland. Bonfires were lighted, crowds formed in the streets, and a band of noblemen escorted her to Holyrood Castle. But all the joy of this welcome vanished on the first Sunday after Mary's arrival.

In France, Mary had been raised in the Roman Catholic faith. Once in Scotland she claimed for herself the right to freedom of worship. Accordingly, she arranged to celebrate Mass in Holyrood chapel on that first Sunday. A furious protest came from the Scotch Protestants. In dismay, Mary cried, "Here is a fine beginning. What will be the end I know not, but I foresee it must be very bad."

John Knox, a Protestant leader, condemned her charms, her gaiety and her religious beliefs. He thought her a frivolous woman, unfit to be a queen. His fiery words aroused many of the Scottish lords against Mary. Her secretary, an Italian, David Rizzio, also received his share of bitter distrust.

In 1565, Mary married her cousin, Lord Darnley, an Englishman who was next to her in line for the throne of England if Elizabeth should die without children. Mary and Darnley had a son, James who, as we shall see, did become king of England.

MARY'S UNFORTUNATE MARRIAGE AND THE CRUELTY OF HER HUSBAND, LORD DARNLEY

The marriage with Darnley was not happy. He was a weak man, easily swayed by malicious persons at court who disliked the Queen. Because Mary trusted Rizzio, Darnley spread evil rumors about them. One evening as Mary sat at supper, Darnley and several of his friends entered her rooms. Rizzio was with the Queen, and she saw immediately that the intruders were after his blood. She tried to protect her faithful secretary, but he was dragged from the room and stabbed to death outside the door.

Mary could never forgive Darnley's brutality. She no longer went to him for advice but turned instead to Lord Bothwell. A year later Darnley was murdered; and Mary's enemies accused Bothwell of a part in the act. Many even accused Mary herself of having a hand in the murderous plot. Mary, however, publicly forgave Bothwell for any evil he had done; and soon after they were married.

The angry lords seized Queen Mary and imprisoned her in the Castle of Lochleven. Bothwell was forced to flee. Mary waited patiently, thinking that foreign kings would rise to rescue her; but nothing of the sort happened. She was forced to resign the throne in favor of her infant son, who became James VI of Scotland (1566–1625). To a friend Mary wrote, "The miseries I endure are more than I once believed it was in the power of human suffering to sustain." As a last resort she escaped to England. She hoped to find a friend and protector in Queen Elizabeth; but Mary again hoped in vain.

HOW QUEEN ELIZABETH OF ENGLAND FEARED HER COUSIN, MARY QUEEN OF SCOTS

Elizabeth feared Mary more than she dared admit. Elizabeth had no children, and Mary was next heir to the throne. Elizabeth was a Protestant, Mary was a Catholic. There were strong Catholic families in England, and France and Spain were Catholic nations. Elizabeth was constantly in fear that Catholic Englishmen, conspiring with France and Spain, might be able some day to drive her from her throne and place Mary there instead. As long as Mary lived, she would be a threat to Elizabeth.

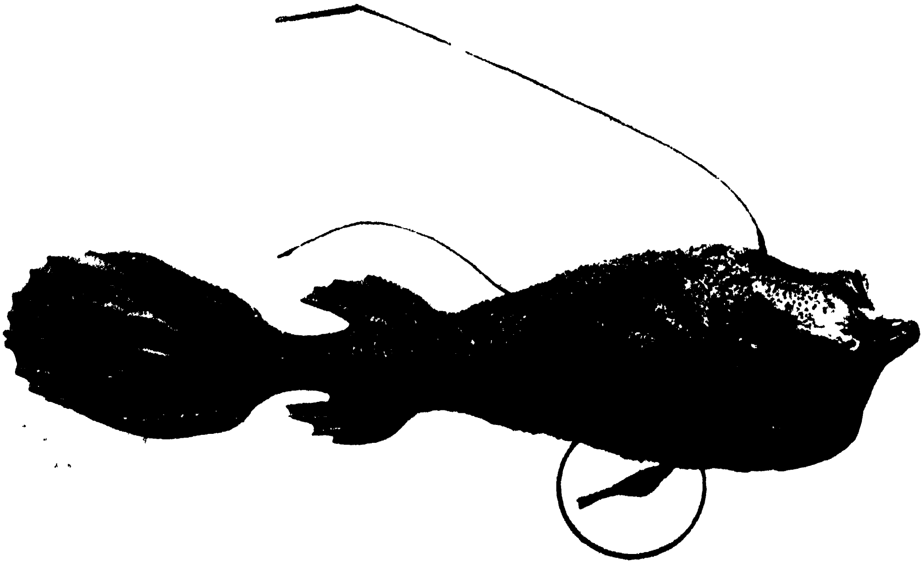
Instead of helping the Scottish queen, therefore, Elizabeth had her imprisoned. For eighteen years Mary was held in an English castle. During that time there actually were many plots to destroy Elizabeth and set Mary on the throne of England. Mary must have known about some of them. We do not know what part, if any, she took in these conspiracies. We do know that none of them succeeded.

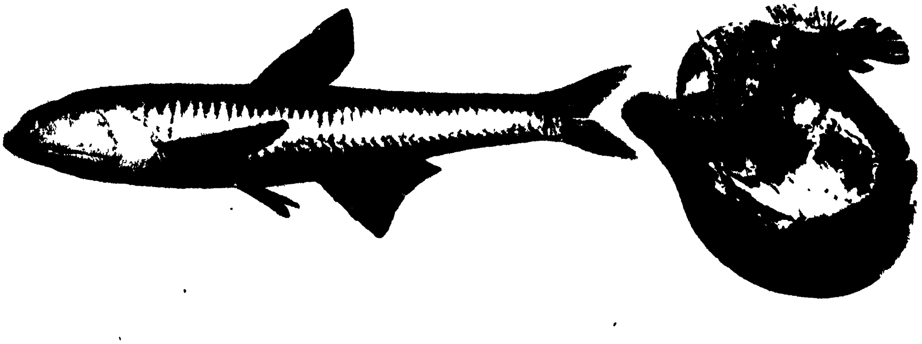
Finally, Elizabeth ordered Mary brought to trial at Fotheringay Castle for plotting against England. "My crimes," Mary told her judges, "consist of my birth, the injuries that have been inflicted upon me, and my religion. Of the first I am justly proud, the second I can forgive, the third has been my sole consolation." But the English judges decided that Mary was guilty of treason. She was condemned to death. Dressed in her regal robes, Mary, former Queen of Scots, walked into the courtyard of Fotheringay Castle to face her executioners at the chopping block. She welcomed death, for it ended her miseries. This was in 1587. When Elizabeth died in 1603, Mary's son, King James VI of Scotland, became King James I of England. Ever after the king of England has been the king of Scotland also.

The early Scottish kings were crowned upon a famous rock at Scone. Edward I carried the stone away to Westminster Abbey, where it is to this day, under the coronation chair, or throne, on which the kings of England (and Scotland) are crowned.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 5704.

NATURE'S RESPONSE TO ENVIRONMENT





Courtesy South Kensington Natural History Museum

THE deep-sea angler fish has recently been receiving special attention at the hands of science. It has certainly developed one of the most amazing adaptions to environment in the form of a luminous blob at the end of a ray of the dorsal fin. Floating about in the darkness of the middle depths of the ocean, between 300 and 600 fathoms below the surface, it is blackish in color, a solitary and sluggish creature feeding on fish. It possesses enormous jaws, may grow to over a yard in length and lies in wait for its prey to come to it. The male is in the last stage of degeneracy, and is only a few inches long. At a very early stage it becomes parasitic on the female Outgrowths are formed from its snout and chin and unite in front of the mouth. On the female are certain protuberances or papillae. The male fastens on to one of these with his outgrowth. His skin fuses completely with that of the female and she meanwhile passes out from her body fibres and vessels, supplying the decadent male with a circulatory system The *Ceratias Holboelli* shown above was 40 inches long and the male (in circle), attached to her for life, was but 4 inches, she being about 1000 times the weight of her husband The angler fish can distend its stomach enormously, as shown in the lower picture of a *Melanocetus* which has swallowed a fish three times its own length and several times its weight. The victim (at left) was seized by the tail and gradually absorbed until it formed a complete circle inside its captor

VOLUME XVI

The Book of Knowledge

The Children's Encyclopedia

THAT LEADS TO LOVE OF LEARNING

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E

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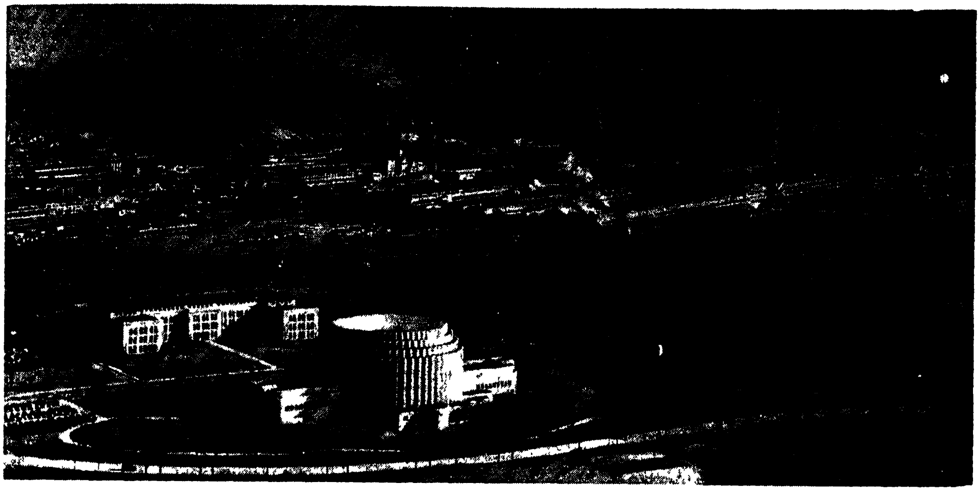


Courtesy Detroit Board of Commerce

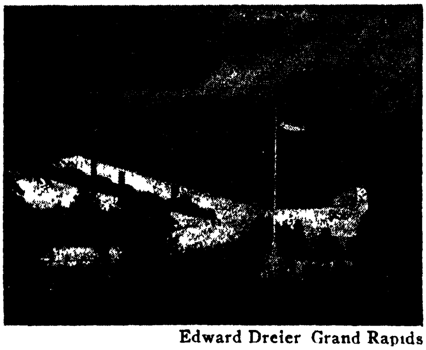
This is where Ford cars are made in Detroit. That big round building in the foreground is the Ford Rotunda.

THE NORTH CENTRAL STATES

PART II

IN the first story of the North Central States we told you of the people and of the agriculture of this region, which includes the states of Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska and Kansas. Now we come to the mines, the manufactures and the means of transportation.

If you draw a line on the map from Chicago to Buffalo, from Buffalo to Pittsburgh, and from Pittsburgh to Chicago, you would have a triangle enclosing the largest iron-and-steel-producing area in the United States. There are iron foundries and steel mills in the Chicago district, in Gary and Hammond, Indiana, in Cleveland and Youngstown, Ohio, and in a number of other towns and cities along the Great Lakes and the Ohio River, yet there is not a great deal of iron ore or coal there. Why do you suppose this particular area has become so important in the production of iron and steel?



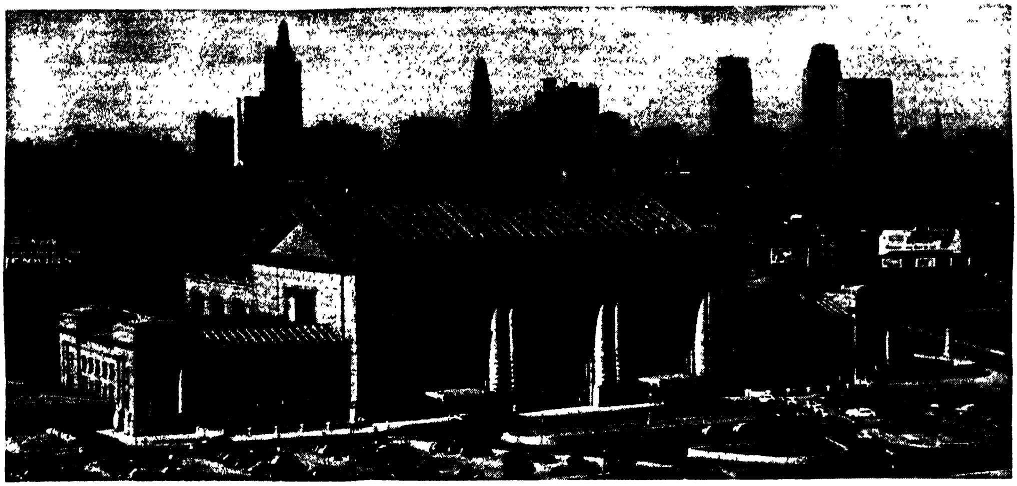
Edward Dreier Grand Rapids

Old fort on Mackinac Island, once a trading post.

Long ago, when the white settlers were between the Appalachian Highlands and the Atlantic seaboard, bog ore was taken from the swamps along the coast, and wood charcoal was used to melt and refine the iron ore. Later the hard coal of Pennsylvania was used, and blast furnaces were built in eastern Pennsylvania. Still later it was found that the soft coal of western Pennsylvania could be made into coke and used to refine the ore, and the industry became very important in Pittsburgh and near-by cities.

As the country spread westward and the demand for iron and steel became greater, the supply of iron ore in the East began to decline. But over one thousand miles away, in Minnesota, rich ore deposits were discovered in a region where no coal was available for reducing the ore. It was necessary to bring the ore and the coal together, and to do it as cheaply as possible.

The answer to this transportation problem was found in the system of waterways



Union Station at Kansas City, Missouri, with skyscrapers of the business section in the background.

that stretch between Minnesota and the Pittsburgh district. Water transportation is not so rapid as rail transportation, but it is much cheaper over long distances. A big ore boat or a string of barges can carry more ore then a freight train. Now railroads bring cars loaded with ore from the mines to Duluth and other lake ports; the ore is dumped from the cars into boats and carried eastward on Lake Superior, through the canal between that lake and Lake Huron, to the ports on the southern shores of Lake Erie. Some of it goes to the Pittsburgh area, but much is now used in the great manufacturing cities of Ohio, Indiana and Illinois.

Pittsburgh is no longer the only large steel-producing city, though it is still perhaps the most important. The enormous growth of the central part of the United States, and the development of its industries, has created a market for steel that could not be handled by a single production district far away in the East. The Calumet region, which includes Gary, Hammond, East Chicago and other places below the tip of Lake Michigan, is now one of the greatest industrial districts in the world.

The soft coal of Illinois has been found to make excellent coke, and this has given rise to another industry of great importance to the lake cities. Coke is made by heating the coal in ovens until the gases and other impurities are driven out. These by-products, as they are called, are used in many ways in industry, and the gas is used, not only by the cities for heating and cooking in homes, but also to heat the coke ovens to produce more coke and gas.

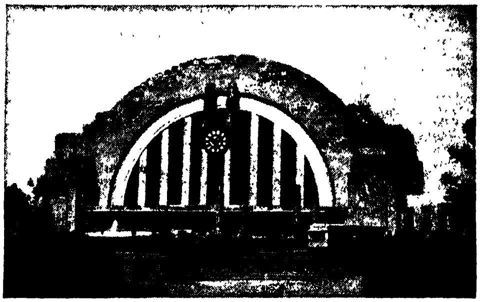
St. Louis once had many blast furnaces. Ore was brought from Pilot Knob and Iron Mountain, a hundred miles away in the Ozarks. As late as 1880 St. Louis was called the "City of the Iron Crown." Today this great gateway city has too many different kinds of manufacturing and trade for any one thing to predominate. There are coke ovens and blast furnaces near by, and all kinds of heavy machinery, railroad equipment and other steel products are manufactured there. St. Louis has also been enriched by its nearness to the huge lead-mining district of the Ozark Mountains. Over on the other side of the state of Missouri, where it joins Oklahoma and Kansas, is the important Joplin zinc-mining region.

Petroleum is another important mineral product found in the north-central states, principally in Kansas and Illinois. For a number of years the oil-fields in eastern Illinois were the most productive in this region, but their output has declined. The Kansas wells, which are a part of the great Oklahoma oil-fields, now produce much more oil than Illinois.

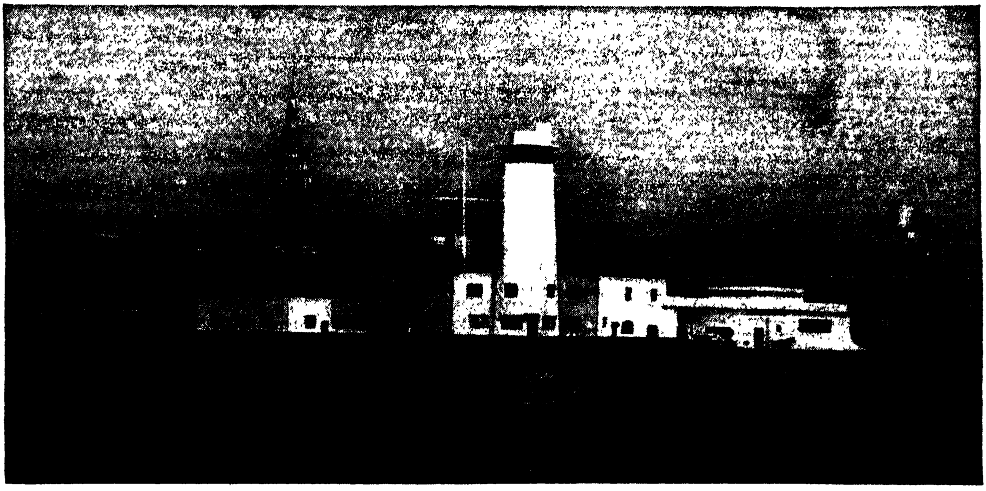
Copper is mined in Michigan. Once Michigan held first place among the states in production of copper. Now it ranks fifth. Michigan is still, however, the leading state in the production of salt. This may seem surprising, since we usually think of salt as coming from places near the sea and Michigan is far from the salt water of the oceans. The answer is a very interesting one.

IN CLEVELAND AND CINCINNATI

Cincinnati, called at first Losantiville, was settled in 1788. It is the second largest city in Ohio. This is a glimpse from the Kentucky hills across the Ohio River. River barges carry considerable freight.



At the left is Cleveland's beautiful marble Art Museum, in Wade Park. It was opened in 1916, and contains many fine treasures. At the right is the Cincinnati Union Terminal. Eight great main line railroads enter Cincinnati.



Courtesy, Cincinnati Chamber of Commerce, Carl McDow, Cleveland Chamber of Commerce

At this commanding point on Cleveland's lakefront (Lake Erie) are the observation tower and other buildings of a United States Coast Guard Station. The thin white cross is a flagpole. Behind is the lofty Terminal Building.

Courtesy, Topeka Chamber of Commerce

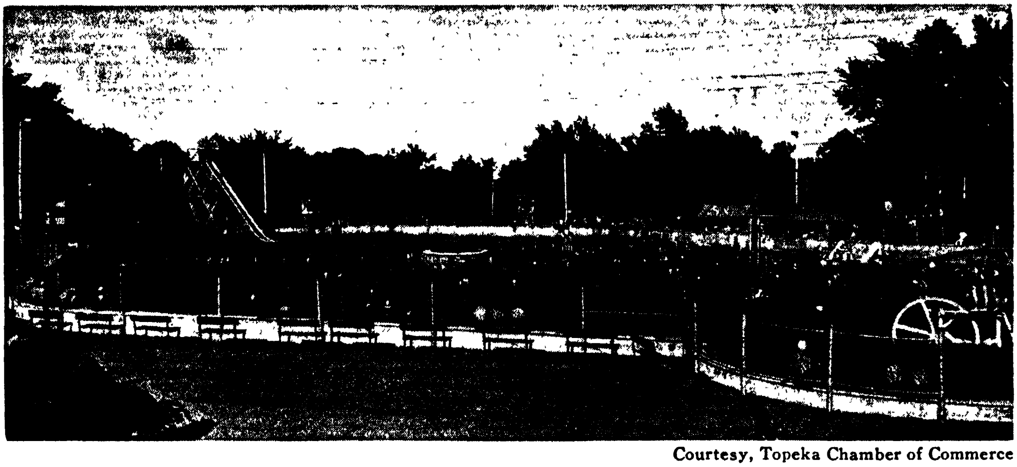
This fine high school is at Topeka, Kansas.

Long ago much of what is now Michigan was under water, covered by an arm of the ocean—a great gulf. The region had less rainfall than it has today, and as the water evaporated, more came in from the ocean. Gradually much salt was deposited on the bed of the gulf. Afterward the salt beds were covered up with large quantities of sand and mud which became rock. The salt beds deep in the ground are the sources of Michigan's salt.

When coal is mined a shaft is sunk into the ground to the vein of coal. Some salt is also mined in this way. But man has been able to get the salt far beneath the ground without sinking shafts. He drills a hole down to the salt beds and drives in two pipes. Hot water is forced through one of the pipes, to dissolve the salt. More water is forced through the pipe, and the hot salty water is forced out of the second pipe. The salty water is then evaporated, and the salt is left in the pans as a solid.

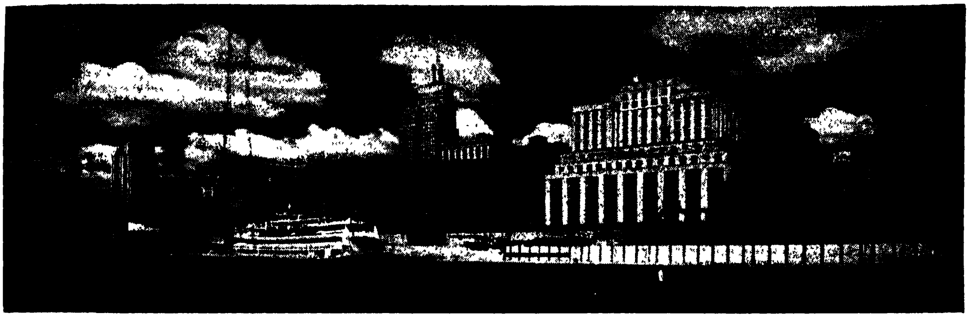
The southern part of this group of states is better supplied with coal than the northern part. A coal-field extends from the central part of Iowa through the northern and western part of Missouri into Kansas. Another coal-field lies in the lower peninsula of Michigan. But the most valuable coal-field is the Illinois-Indiana-Kentucky coal-field. There are many mining towns in southern Illinois. In most places the coal is deeply buried beneath the surface. Hillside mining and pit mining, therefore, are not very important. Most of the coal is secured by shaft mining. A shaft is sunk to the coal vein, and long tunnels are formed underground.

As you may well imagine from what we have told you about this region, commerce on the Great Lakes has become enormous. Commerce on the big navigable rivers, such as the Ohio, Missouri and Mississippi, has also increased amazingly in recent years. When the railroads were first built the effect upon river transportation was disastrous. For many years it seemed that the rivers would never again be the great arteries of commerce that they had once been. However, as the center of the United States became more thickly populated, and industry as well as agriculture became highly developed, it was found that there was quite enough commerce for both the rivers and the railroads. The building of canals and the dredging and straightening of the river

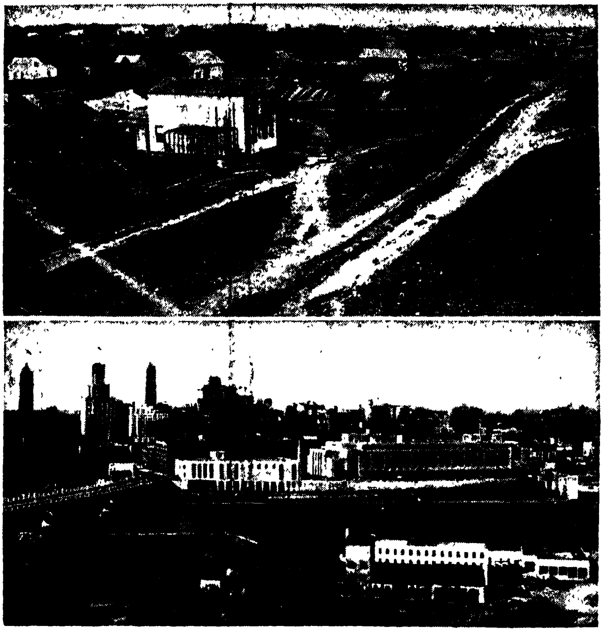


Courtesy, Topeka Chamber of Commerce

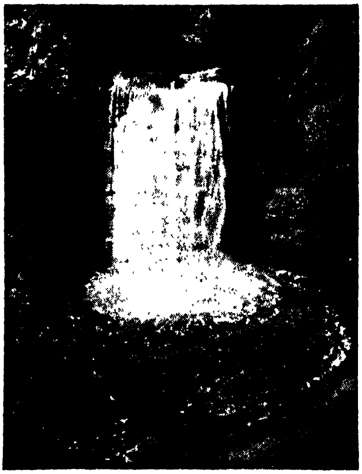
One of the largest concrete swimming pools in the Middle West is in Gage Park at Topeka, Kansas.



Above is the skyline of St. Paul, one of the famous Twin Cities of Minnesota on the Mississippi River. The Federal Building is in the foreground, the Court House and City Hall at the far left. The skyscraper is the First National Bank.



Minneapolis, the other Twin City, has an equally striking skyline. Famed as the Flour City, it has grown rapidly as you can plainly see by comparing the scene above, as it was in 1857.



Courtesy, Minn. Civic & Comm. Assn.

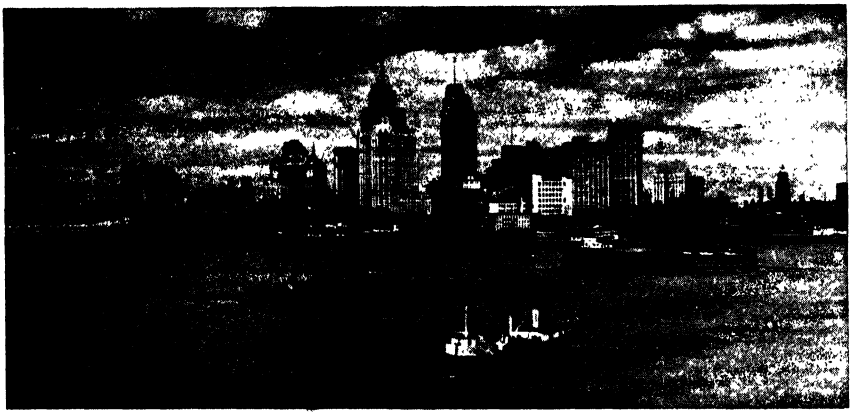
Longfellow describes the Falls of Minnehaha in the "Song of Hiawatha." Their Indian name means "curling water."

channels did away with some of the greatest obstacles to river traffic, and today it is estimated that the tonnage carried on the Mississippi alone is greater than at any time in the river's history.

Chicago some years ago completed the Chicago Drainage Canal through which water from Lake Michigan flows into the Illinois River, a tributary of the Upper Mississippi. This canal was built primarily to dispose of the sewage of Chicago but it also forms the connecting link in the Lakes-to-Gulf waterway, long one of Chicago's favorite projects. The waterway was opened on June 22, 1933. Barges may now travel directly between Chicago and New Orleans. Ocean steamers now ply between Chicago and European ports, by way of the Great Lakes. The city is the center of many aviation routes.

Chicago was located at the mouth of the Chicago River near the southern end of Lake Michigan. This settlement became a lumber center, since it was between the prairies to the south and west and the northern forests. In this city coal from southern Illinois meets iron ore from the Lake Superior mines and large blast furnaces refine the ore. To the south and west is the best-developed large area of farm land in the United States. Most farming implements are made of iron and steel and wood. Chicago leads all cities of

The Art Center and Michigan Boulevard, in Detroit, now the fourth largest city in the country.



Downtown Detroit is on the bank of the river which divides Canada from the United States.

the Union in the production of farm implements.

It is more economical to send animal products to consuming markets in the form of meat and lard than to send live animals. Meat-packing plants, therefore, are near the farms where the animals are fattened for market. Chicago reaches out into the Corn Belt and beyond, with its many radiating railroad lines. Thousands of cattle, hogs and sheep are sold from Chicago, the world's largest meat-packing center. Other cities farther west, as St. Paul, Omaha, Kansas City and St. Louis are also important "meat markets."

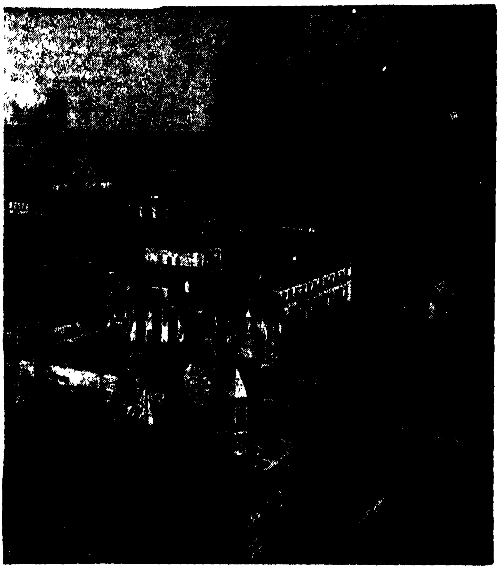
Railroad lines connecting the East with the region west of Lake Michigan must pass around the lake. These lines all run into Chicago. This city no longer depends on the mouth of the river for its harbor. A great artificial harbor has been built in the lake. So many railroads have been built to Chicago that it has become the greatest railroad center in the world. The many radiating railroad lines have helped Chicago to become the largest grain market of the United States.

Milwaukee, Wisconsin, another of the lake cities, is noted both for the number and the variety of its factories. It consumes more steel than any other city in the United States. In dollars and cents its largest industry is the manufacture of farm machinery including tractors, and of machinery for road-making. It is said that 90 percent of the primary road-building machinery used in the construction of Boulder Dam was made here. The second largest industry is the making of automobile bodies and parts. The meat-packing industry is also important. This city packs more veal than any other city in the country. Milwaukee Bay is famous for its beauty.

Toledo and Cleveland, Lake Erie cities, were located at the mouths of small rivers. Detroit was located on a narrow passage between Lake Huron and Lake Erie. These cities have the same general advantages in securing raw materials and in shipping manufactured products that the Lake Michigan cities have. Toledo has large flour mills. Detroit is the leading automobile center of the world. Cleveland also makes many automobiles and a great variety of iron and steel goods. Not far from Cleveland, at Akron, Ohio, is centered the manufacture of automobile tires.

In the early part of the last century, St. Louis was larger than Chicago, and Cincin-

Courtesy, Chamber of Commerce, Des Moines
The State Capitol of Iowa, in Des Moines, built in a very ornate style of architecture.



F. S. A.
Dubuque was named for Iowa's first white settler, a French trader who came here to mine lead in 1788.

nati was larger than Cleveland. Now, Chicago is well over three times as large as St. Louis, and Cleveland is about twice as large as Cincinnati. What happened is that the lake cities began to push ahead of the river cities when canals were built. One canal connected Cleveland with the Ohio River, another canal connected Chicago with the Illinois River. The lake cities reached out and captured commerce that had been going to the river cities.

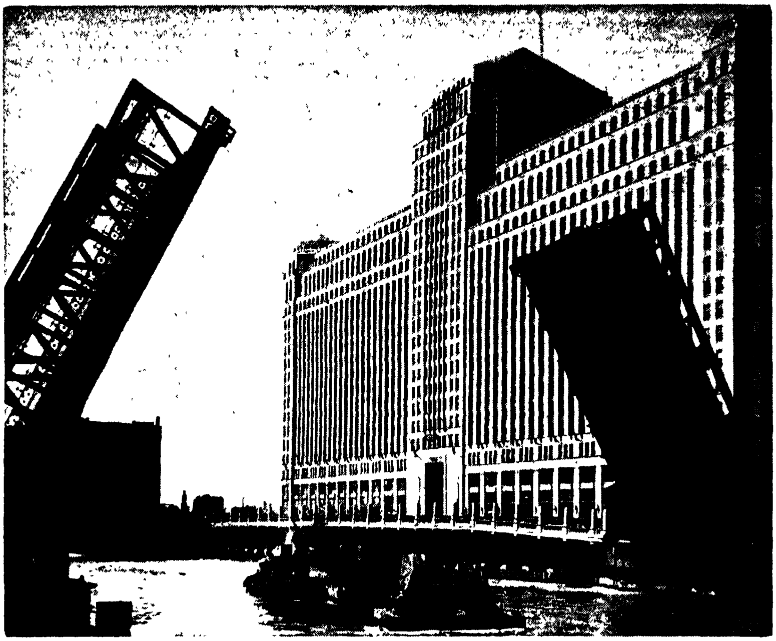
While the lake cities have grown more rapidly than the river cities, the river cities have not decreased in population, but have also grown very rapidly. Cincinnati was located on that part of the Ohio River which is nearest to Lake Erie. Meat products, so important in the early days that it was called "Porkopolis," are still important. The hardwood forests of Kentucky and Tennessee are not far away, while iron and steel can be brought by rail or water from the Pittsburgh district or from the iron-and-steel centers of the Great Lakes. The leading industry is the manufacture of machinery for mines and factories and of implements for the farms.

St. Louis was founded on the Mississippi River at a favorable site about twenty miles below the mouth of the Missouri River. Its location between the mouths of the Missouri and Ohio rivers gave it an early advantage when the rivers were the chief arteries of commerce. St. Louis now has twenty-six railroad lines extending into its trade territory, and is called the gateway to the Southwest. Its location has made it a large wholesale center. The food and allied products industry is the most important; the chemical and allied products industry ranks next. St. Louis is very fortunate in that it manufactures so many different things that a business depression along a few lines does not affect it.

Kansas City and Omaha depend for their prosperity on the farm lands near by as well as the Great Plains to the west. Both cities are impor-

Courtesy, Milwaukee Assn. of Commerce
Lincoln Memorial Drive and Parkway along the lake in Milwaukee.

tant livestock centers, and meat-packing is an important industry. Kansas City is located at the elbow of the Missouri River. Omaha had the advantage of being on the line of the first railroad built across the United States.

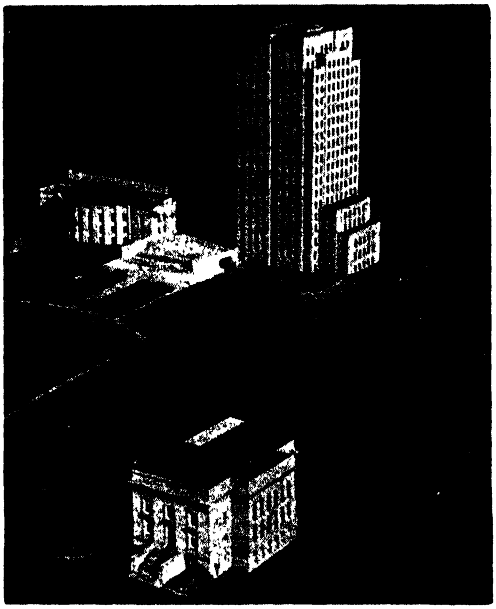


Keystone-Underwood

Chicago's Merchandise Mart is one of the world's largest buildings.

Indianapolis is the one large city of the north-central states that is not on a navigable body of water. It is the capital of Indiana, and is surrounded by a rich farming region. Railroads and interurban lines radiate from Indianapolis as spokes from the hub of a wheel. Meat-packing is an important industry.

We have noticed the importance of the farms, the forests and the mines. We have studied the development of commercial and industrial centers. The people of the cities depend on the people of the farms, mines and forests for their raw materials and food. The cities in turn supply manufactured products and redistribute supplies.



Courtesy, Bismarck Assn. of Commerce

The skyscraper State Building of Bismarck, North Dakota, stands out against the prairies.

When we put together the different things we have learned about the north-central states our picture should include the spring-wheat region, the winter-wheat region, the dairying region, the mixed-farming region of the Corn Belt, the fruit districts, the location of iron, copper, salt, coal, petroleum, lead and zinc mines, the northern forests and the forests of the Ozark Upland, the many railroads, and the commerce of the Great Lakes and the Mississippi River system. We should picture the location of several of the largest cities.

We should not think of these things as symbols on a map. Cities should not be mere dots, rivers should not be mere crooked lines. Our pictures of the industries of this region should not be merely word-pictures. We should think of the thousands of people who are at work on the farms, in the mines, in the forests and in the factories. We should think of the thousands of homes and of the many comforts made possible because of the work that is being done.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 5789.

Courtesy, Handy & Harman, N. Y.

Inspecting sterling silver for correct dimensions and imperfections. Sterling is the name given to a standard alloy of silver. Actually, it is composed of only ninety-two and a half per cent silver. The rest is copper.

METALS *and* NON-METALS

IF you think of all the great number of things there are in the world, you quickly realize that there must be hundreds of thousands of different materials used to make them. Yet all these hundreds of thousands of materials can be made by different combinations of ninety-odd very simple substances. Most of these simple substances are called either metals or non-metals.

You probably know a few materials that are metals. Gold and silver, and perhaps platinum, you have seen in jewelry. Tin cans are made of two metals—iron, coated with tin. The "tinfoil" in which candy is sometimes wrapped is really made of lead. Some saucepans are made of aluminum. So, you see, you already know a little about some metals. But about non-metals? Is wood a non-metal? It certainly is not a metal; but that is not quite enough to make it a non-metal in a scientific sense.

Before you call something a non-metal you have to be sure it is such a simple substance that it can not be changed into anything simpler. Take rust, for example. That is a red powdery material that certainly does not look like a metal. Yet if you put it in a very hot furnace with coke, a black material very like coal, and then let the mixture cool, you will find that the metal iron has been formed. So, rust can not be called a non-metal.

What happened in the furnace? Did the rust join forces with another substance to make iron? Or was part of the rust taken away, leaving iron behind? The only way to decide what has happened is to weigh the rust that you start with and the iron that you get. Then you always find that the iron weighs less than the rust. That must mean that in the furnace part of the rust has been taken away, leaving iron behind.

Almost all the materials you see around you—wood, silk, salt, sugar, glass, chalk—can be broken up into several different substances. Since they are made up of more than one substance, they are called compounds. Rust is a compound. There are a few materials, however, like iron and soot, that can never be broken up into anything simpler. These are called elements. (Soot is a form of carbon.)

Most of the metals that you know are also elements; they can not be broken up into simpler substances. Now, if you can find an element that is not a metal, you can call it a non-metal! You probably do not know so many non-metals as metals, but soot (carbon) is one, and the chlorine that is used to kill germs in some swimming pools is another.

One of the most interesting non-metals was discovered by people who were trying to find out what happened when there was a fire. If you float a candle in a dish of water, light it and turn a glass jar upside down over it so that the glass is partly under water, the candle will burn for a while and then go out.

As the candle burns, the water rises up inside the jar. No matter how often you try the experiment the same thing always happens. The water always rises about a fifth of the way to the top of the jar. The only way to explain this is to say that when the candle burns, some of the air is used up and the water rises to replace it.

Wouldn't you expect, then, that the candle would keep burning until all the air is used up and the water has risen to the very top of the glass? Since only a fifth of the air is used up, it must be that this fifth of the air is different from the rest. A Frenchman, Antoine Lavoisier, who first discovered this fact, gave the name oxygen to the part of the air that is used up when something burns.

UNLIKE SOLIDS AND LIQUIDS, GASES ARE VERY DIFFICULT TO HOLD IN ONE PLACE

Oxygen was discovered less than two hundred years ago, although men have been watching things burn for thousands and thousands of years. Why was it so difficult to find? Well, oxygen is a gas, and gases can not easily be kept in one place. You can put a liquid, like water, in a glass and it stays there; you can leave a solid, like a piece of chalk, on the table and expect to find it there when you come back. But when you open a soda bottle, or a ginger ale bottle, the gas in it starts fizzing out and will be all gone if the bottle stands around open for a few hours.

You can not see or taste or smell oxygen. You know there is a gas in a soda, because you can see it bubbling out. You know that the gas you use in a gas oven is there because you can see it burn when you light it, and you can smell it if it is escaping. But it took a very clever man to observe what happens when things burn and thus to figure out that a fifth of the air is oxygen.

The next step was to get some oxygen all by itself. A chemist did this by heating a red powder that contained oxygen and another substance. When the compound was hot enough, the powder gave up its oxygen; the oxygen could be collected by letting it bubble into a bottle of water that was upside down in a dish of water. The water was forced out of the bottle as the oxygen came in. When all the water was out, the bottle was full of oxygen.

It could be shown to be pure oxygen. The bottle was set upside down over a dish of water that had a burning candle floating on it. The candle would not go out until the water had risen all the way up in the bottle. (Of course, the candle had to be very short, so that it did not get crushed against the top of the bottle as it rose with the rising water.)

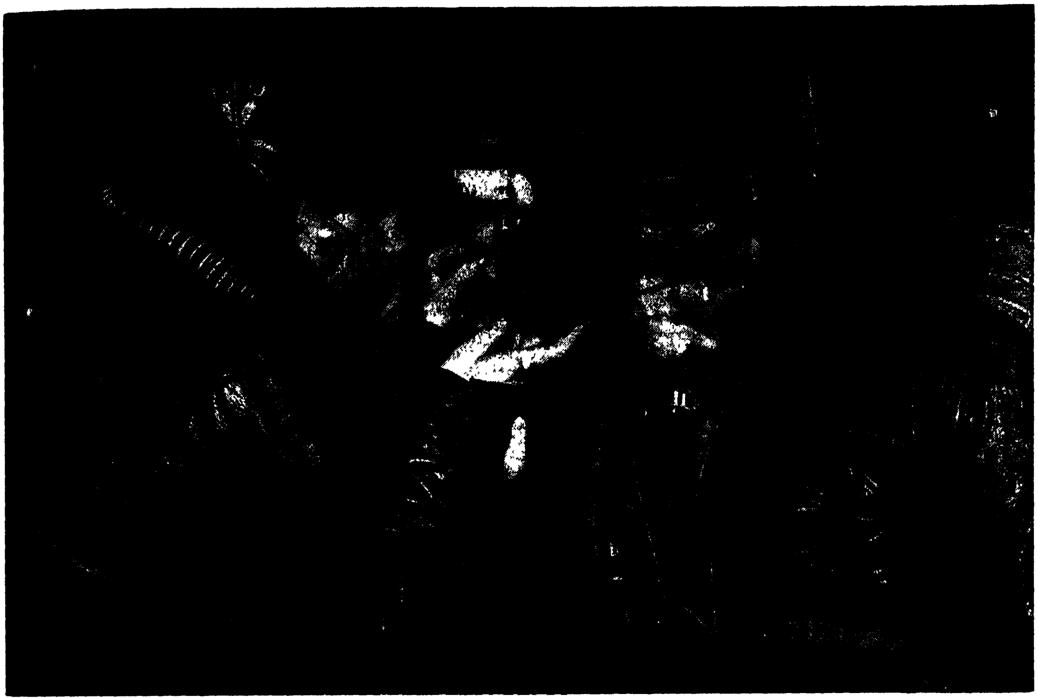
Nowadays you can make oxygen much more easily and cheaply than by heating a rare, expensive, red powder. One way is to get it from water. Water is a compound that will break up into two elements if you can make an electric current go through it. Take a battery, like the ones you use in a flashlight, only larger, and fasten a wire to the outside terminal and another to the center terminal. Dip the ends of the two wires in a glass of water. Nothing happens. The electric current can not pass through the water. Now put a very little sulfuric acid, or a white powder like Epsom salts, in the water and try again. You will see bubbles of gas being formed from the water where each wire enters it.

You can collect the gases by holding a bottle full of water over the bubbles at the end of each wire, until all the water has been forced out of each bottle. One of the two bottles contains oxygen. Many materials burn in it. A smoldering piece of wood that is barely glowing in air will burst into a bright flame in the oxygen.

Even a piece of iron will burn with brilliant sparks in oxygen. After the iron has finished burning, there is a black substance left in the bottle that weighs more than the iron did originally. Since there was nothing but the iron and the oxygen in the bottle, the only way to explain what has happened is to say that the iron has combined with the oxygen. All metals, except platinum and gold, will act this way in oxygen; the combination formed of the metal and oxygen is called an oxide. Some non-metals, also, can be made to burn in oxygen and form oxides.

HOW OXYGEN IS SEPARATED FROM THE NITROGEN AND OTHER GASES IN THE AIR

Another way to make oxygen cheaply is to get it from air. As we have seen, oxygen makes up one-fifth of the air. The other four-fifths is almost entirely another gas, nitrogen. Separating the oxygen from the nitrogen is not easy. The only way to do it is to make the air into a liquid. You probably know that a liquid like water can be turned into a gas, steam, by making it hot enough. You have also probably seen the steam turn back into drops of water as it cools. If you can find the right temperature, you can make any liquid change to a gas and any gas change to a liquid. So air, a mixture of two gases, will change to a liquid if it is made extremely cold. Then, if you let it



Courtesy, The Sperry Corporation

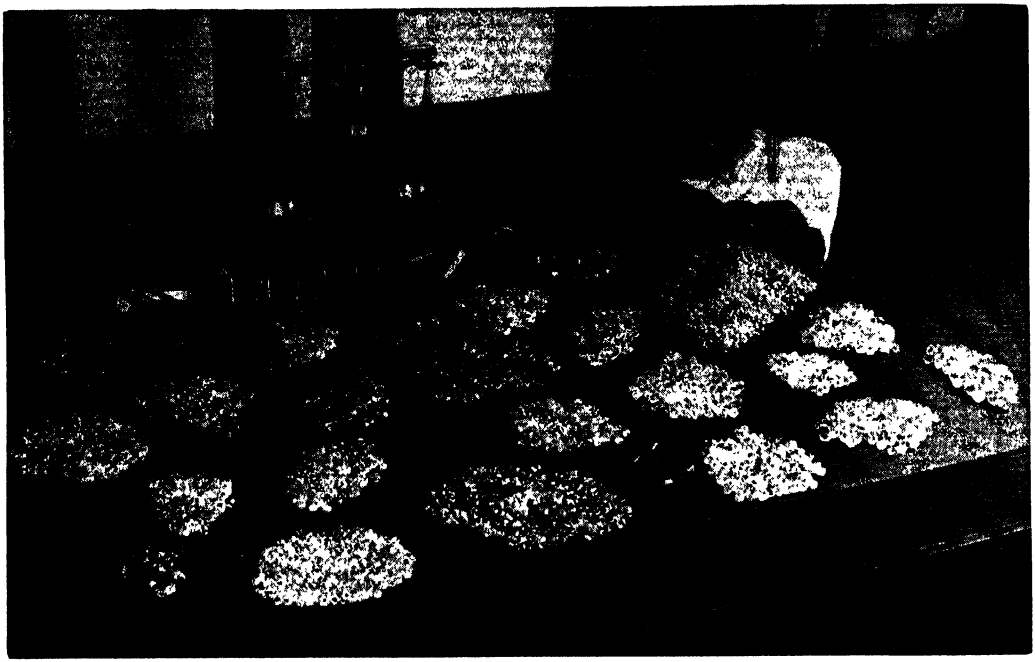
Testing oxygen masks to see that they fit perfectly. No air should leak in to mix with the pure oxygen.

heat up slowly enough, all the nitrogen will boil, that is, change back to a gas, before the oxygen does. In other words, the nitrogen boils off, leaving the pure liquid oxygen. This can be put into a container, ready to be used whenever it is wanted. Flyers go high in the sky, where the air is so thin that there is not enough oxygen for ordinary breathing. They take along tanks of oxygen to breathe when they need it. People who have trouble in breathing through illness can also be helped by being put in an "oxygen tent." Thus they take in pure oxygen with every breath.

When we passed an electric current through water, we collected two bottles of gas, one from each of the wires. We found that one bottle contained oxygen. What about the other? If you tried to burn a piece of wood in it, you would find that the wood did not burn. Instead, the gas would catch fire and burn at the mouth of the bottle, rather like the way the gas in a gas oven burns when you light it. And if you looked closely after all the gas in the bottle had burned and the bottle had cooled down a bit, you would probably see a few drops of water in the bottle. What happened? The gas in the bottle was hydrogen. When you lighted a match near the neck of the bottle, hydrogen atoms and oxygen atoms (from the air on the outside of the bottle) joined together in the heat of the match, forming molecules of water.

The gas hydrogen is another non-metal. Because it combines with oxygen so readily, it is never found in air, but only combined with other elements in compounds. Besides water, many sour-tasting substances, called acids, contain hydrogen. It is even easier to get hydrogen from acids than from water. All you have to do is drop a piece of a metal, iron or zinc, perhaps, into some acid, such as sulfuric acid. Immediately you will see the acid start to fizz. The bubbles that are formed are hydrogen.

This gas can not be tasted or smelled or seen, any more than oxygen can. But in every other way it is very different from oxygen. For one thing, it is the lightest substance known. If you fill a toy balloon with hydrogen and let the balloon go, it will rise right up to the ceiling instead of falling to the floor! When balloons and blimps were first being used for flying, they were filled with hydrogen to make them rise. But if the hydrogen gets hot, or there is a flash of lightning, or even just a little spark, it will burn fast and violently. So it is not safe to use hydrogen in blimps. Nowadays, whenever



Wide World photos

A diamond is a form of carbon. In addition to being valuable as jewels, diamonds are used as cutting instruments because there is no harder substance known. The industrial diamonds shown here are worth about $750,000.

possible, the second lightest gas, helium, is used. Helium is a little heavier than hydrogen; but it will not burn. Hydrogen has such a strong tendency to unite with oxygen that it can be used to remove the oxygen from a metal oxide, like rust or copper oxide, leaving pure iron or pure copper. Because hydrogen produces so much heat when it burns, a flame of hydrogen burning in oxygen can be used to melt metals in order to join, or weld, them together.

When we were talking about oxygen, perhaps you wondered about the other four-fifths of the air, the nitrogen. Since it is part of the air, you know that it is a gas that has no smell, no taste and no color. Unlike hydrogen, it does not burn; and, unlike oxygen, things do not burn in it. In fact, nitrogen is usually called inactive because it is so hard to make it combine with other substances. That is unfortunate; compounds that contain nitrogen are greatly needed. They are put on the ground to make plants grow better; they are used to make explosives like dynamite and gunpowder; they are even needed in food, and to make materials like nylon, and for many kinds of medicines. With so much nitrogen in the air, it would cost very little to make these compounds, if only some way were found to make the nitrogen unite with another element.

Actually, three ways have been discovered to "fix" nitrogen by getting it to combine with another substance. One way—which was much used thirty-odd years ago—is to get a mixture of nitrogen and oxygen very hot, several thousand degrees, and pass an electric spark through the mixture. Then the two gases combine to form a new gas, an oxide of nitrogen. The oxide can be used to make an acid, called nitric acid, which is a starting-point for most of the other important substances that contain nitrogen.

The second way of fixing nitrogen is used a great deal today. Starting with lime and coke and nitrogen heated extremely hot in an electric furnace, it is also possible to get nitric acid. The third way is rather like the first, except that instead of oxygen, hydrogen is used; the mixture does not have to be so hot, only several hundred degrees. The mixture of nitrogen and hydrogen must be made to occupy a very small space. Very great pressure is used to force it into a small, strong container.

When they combine, the two gases form still another colorless gas, called ammonia. Ammonia has an extremely strong smell. You may have smelled it, for sometimes a liquid called "ammonia" is used in the kitchen to help with cleaning. The smell is the same as that of ammonia gas, although the liquid is really a solution, formed by dissolving some of the gas in water. Ammonia gas does not burn easily, as hydrogen does; but if a mixture of ammonia and oxygen is heated and there is some platinum put with it, it does burn and nitric acid is produced.

The three non-metals that we have described—oxygen, hydrogen and nitrogen—are colorless gases. There are many non-metals that are not gases, and some that are gases but not colorless. Chlorine is a gas that has a pretty greenish yellow color. If you see some of it in a corked glass bottle, you think: "How pretty!" But if you take out the cork and smell it, you stop thinking that. It has a very unpleasant, sharp odor, and if you breathed much of it, it would be poisonous. Even a little is enough to make you feel as if you had a cold. For all that, chlorine is a very useful gas. It is far more poisonous to disease germs than it is to you. A very little of it put in a swimming pool or in a city's water supply, hardly enough to be tasted, will kill the germs in the water so that people do not get sick from swimming in the pool or drinking the water.

Since chlorine is useful, you might want to find out how to make it. You can not find pure chlorine anywhere; you have to make it from one of the compounds that contains it. The best known compound that contains chlorine is ordinary table salt. Chlorine can be obtained from salt in a manner similar to the way in which hydrogen is obtained from water. The salt is dissolved in water and an electric current passed through by two wires connected to a battery. Bubbles of gas form at the end of each wire and can be collected in bottles. One of the gases is colorless; the other is the greenish yellow, sharp-smelling chlorine. (The colorless gas is hydrogen and comes from the water, not from the salt. We shall see what the other element in salt is like when we describe some metals.)

Although chlorine is so poisonous, there are many ways in which it is like oxygen. If you force hydrogen through a tube into a jar of chlorine and light it, it will burn in the chlorine as it will in oxygen. A lighted candle, a piece of hot iron and almost any other metal will burn in chlorine, making flames and sparks, and getting very hot. If you look in a bottle where iron has been burning in chlorine, you will see that a reddish, rust-

Courtesy, American Red Cross

Pure chlorine gas would be quite poisonous if you breathed much of it. Nevertheless, it is very useful because of the fact that it is still more deadly to disease germs. A little of it in a swimming pool will purify the water.

like substance has been formed. This rusty substance always weighs more than the iron that was originally put in; so you know it must be a compound of iron and chlorine. The substances that are formed when a metal burns in chlorine are called chlorides. Salt is one of these chlorides, resulting from the burning of sodium, a metal, in chlorine. There is so much salt in the earth and in the oceans that we do not need to make it.

Courtesy, Liquid Carbonic Corporation

Dry ice is made by freezing liquid carbon dioxide.

Many non-metals are not gases, but solids. Carbon is one. There are several forms of carbon. One is the black powder that is usually called soot; it is formed when you burn a cork or a candle. You can notice it when a candle burns and you hold a plate above the candle flame. The plate becomes covered with soot. Another kind of carbon that you may have seen is a diamond. In addition to being so lovely that it is used for jewelry, diamond is the hardest substance known. It will cut glass easily. Tools for cutting hard materials often have cutting edges made of diamond. You may find it difficult to believe that diamonds and soot are made of the same substance; but if you remember that snow and ice are both solid water, it may not seem quite so strange that diamonds and soot are both solid carbon.

A third kind of carbon is graphite. Graphite is made of little smooth, shiny, black particles that feel slippery when you let them run through your fingers. Because it is so slippery, it is used like oil to grease metal parts that have to slide smoothly past each other; and because it is soft and makes a black mark, it is mixed with clay and used to make the "lead" that is put into pencils. Charcoal, coke and coal are also substances that consist mainly of carbon.

Carbon is inactive ordinarily, but if it is very hot it burns readily. In fact, one way to tell whether a stone is really a diamond is to see if it will burn. Unfortunately, after you have done that, you no longer have any diamond left; so there is not much point in testing it that way!

BURNING CARBON PRODUCES TWO GASES: ONE IS POISONOUS AND THE OTHER IS USEFUL

When carbon burns it seems to disappear. Really, the oxides of carbon that are formed are colorless, odorless gases. Either one of two gases may be formed: carbon dioxide, if there is much air or oxygen around; carbon monoxide if there is less air or oxygen. Carbon dioxide is a useful substance. Plants use it to make sugar and starch for food; it is the gas that is put in water for sodas, to make them fizz. It can also be frozen to a white solid, called dry ice, that keeps ice cream and other foods cool. Carbon monoxide, on the other hand, is very poisonous. A person may die if only one thousandth of the air he is breathing is carbon monoxide. It is even more dangerous than chlorine, since it has no color and no smell and you can not tell whether there is any around. Also, you are not likely to make chlorine unless you are trying to, but carbon monoxide may be formed accidentally if a fire in a stove or furnace does not have enough air. There is almost always some carbon monoxide formed in the exhaust of a car. It is very dangerous to be in a closed garage where the engine of a car is running, or even to sit in a car that is not moving if the engine is running and all the windows are closed.

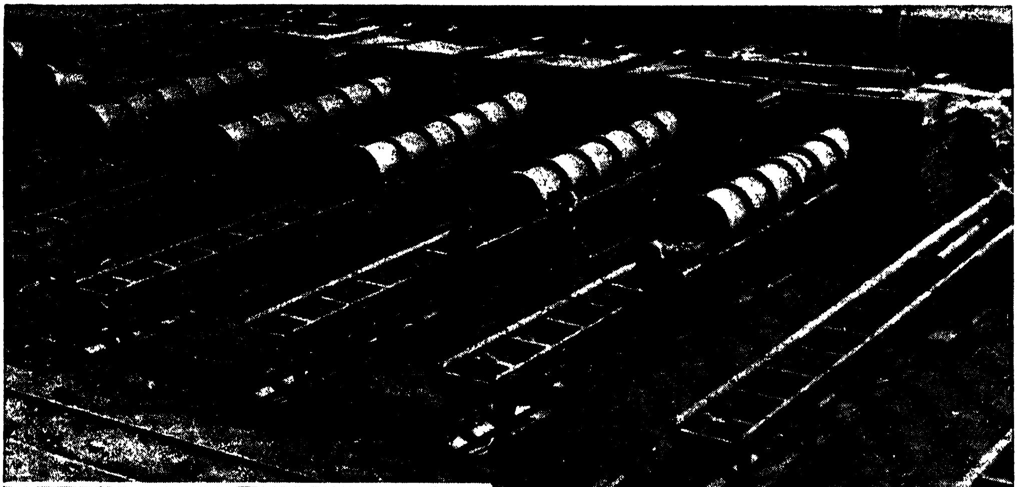
When carbon is hot, it has such a great tendency to combine with oxygen that it will take oxygen away from oxides, leaving the other element in the oxide free. We shall see, when we talk about metals, that one of the best ways to get pure metals, like iron, copper and zinc, is to heat the oxide of the metal in a furnace with coke. Carbon monoxide gas or carbon dioxide gas is formed and goes off up the chimney, leaving the pure metal.

There are hundreds of thousands of different compounds that contain carbon. Most of them are rather different from compounds that do not contain carbon. They will be described in another chapter under the title Organic Chemistry.

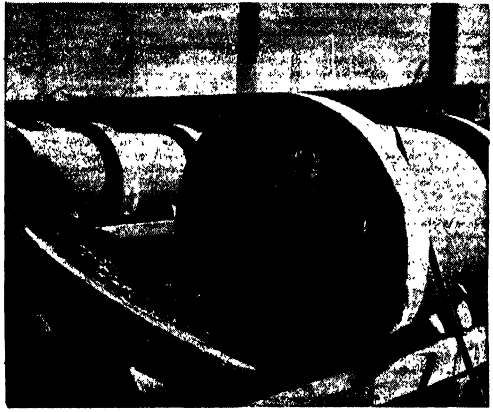
AT A LOUISIANA SULFUR MINE

Courtesy, Freeport Sulphur Company

This sulfur is melted underground with hot water, pumped to the surface and then allowed to solidify in huge bins.



Courtesy, Iodine Educational Bureau, Inc., N. Y.
Chile supplies most of the world's iodine. After chemical treatment the iodine collects in these pipes.



Courtesy, Iodine Educational Bureau, Inc., N. Y.
Iodine as it condenses in the pipes shown above. It is obtained from saltpeter, which is sodium nitrate.

One of the non-metals that has been known for many thousands of years is sulfur. In the Bible it is called "brimstone," and it does look like a stone, a bright yellow one. It is found in the ground in Sicily and Texas and other places, where there are volcanoes or where volcanoes used to be. Sometimes it is dug out of the ground like coal. But sometimes mine tunnels can not be made where the sulfur is, because the ground is too soft. Then a hole is bored and pipes are put down the hole till they reach the sulfur. Very hot steam and compressed air are forced down the pipes; the steam melts the sulfur and the air forces the liquid sulfur up above ground where it is piped to big tanks to be stored.

Sulfur, like oxygen and chlorine, will combine with a great many other elements. It combines with hydrogen to make a very unpleasant-smelling, poisonous gas called hydrogen sulfide. That is the gas that is formed in rotten eggs and makes them smell so bad. Metals like copper and iron and zinc combine with sulfur when they are heated with it, to form solids called sulfides. If sulfur is heated in air or oxygen, it burns to form an unpleasant, sharp-smelling gas called sulfur dioxide. This is an important substance because it is used to make sulfuric acid. Many other substances contain sulfur, almost all of them having strong, disagreeable odors; the compounds that smell so strong in onions and in garlic contain sulfur.

There are many other non-metals that we have not mentioned, but we have not space here to describe them all. We shall speak of one more here, one that you have probably seen, iodine. You may be surprised to hear that iodine is a gray-black, shiny substance. The "iodine" that you have used on cuts appears to be a brown liquid; actually it is formed by dissolving a little solid iodine in a great deal of alcohol. In that way it can be used to kill the germs that may have got into a cut, without being so strong that it burns you badly.

Iodine is like chlorine in many ways. As you see, it kills germs. It is not a gas at normal temperatures; but if you heat it, it readily changes to a very pretty purple gas. If you mix it thoroughly with metals, such as iron and zinc, it will combine with them to form compounds that are called iodides. It is not so easy to make pure iodine as to make pure chlorine. It can be made from a substance called sodium iodate that is found in Chile. Some kinds of seaweed, like kelp, contain a good deal of iodine; some iodine is obtained from the ashes left after this seaweed is burned.

Both iodine and chlorine are members of a special non-metallic group of elements, called halogens. Fluorine and bromine are the other two elements in the family. Bromine is the only non-metal that is normally a liquid.

Halogen is a word derived from the Greek, meaning "salt-former." The four halogens are very similar in their properties; when reacting with sodium, all of them produce a substance that is close to common table salt.

Now we come to the metals. Gold and silver are two metals for which men have been searching and fighting for thousands of years. They are called "noble" metals because they are lovely and valuable, and also because, like nitrogen, they are inactive and do not combine readily with other elements. A modern addition to the noble metals, discovered only two hundred years ago, is platinum. It is even more valuable and more inactive than the other two. Neither gold nor platinum is ever found combined with any other element. Almost all the other metals are found only in compounds, called minerals, or ores. Chunks of gold are usually mixed with quantities of sand and earth. One way to separate them is to "wash" the mixture with a stream of water; that carries away the light earth and leaves the heavy gold behind. The main use of gold now is in making jewelry and ornaments. Once it was in great demand for coins.

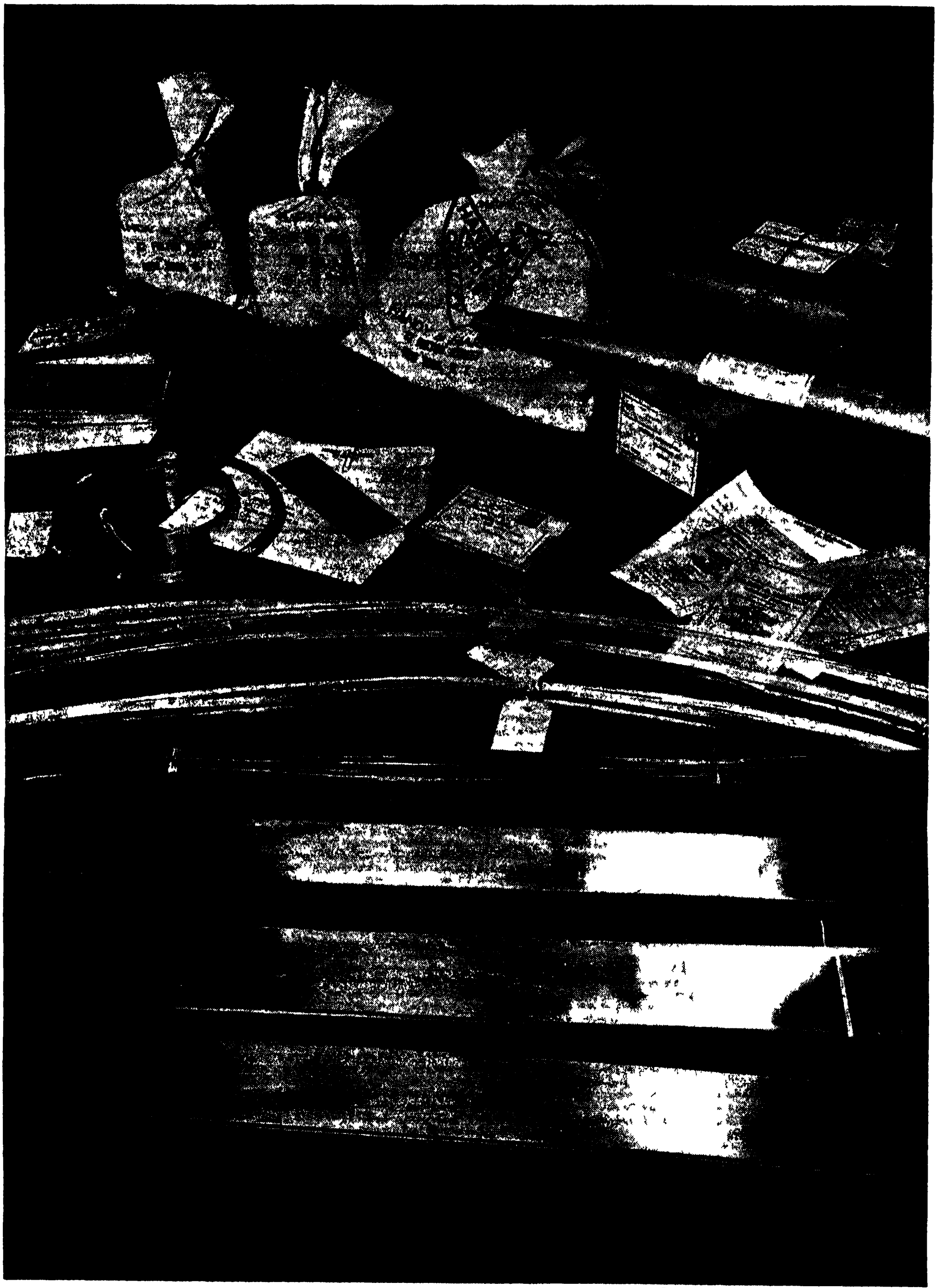
Courtesy, Canadian Department of Trade and Commerce

Probably the first metal that ever came to the attention of man was gold. Largely mined by either "washing" or drilling procedures, it is then refined for use. Here, a man removes the impurities from a cooled gold brick.

Most of our platinum comes from Russia or South America. Jewelers use it, and it is extremely useful to chemists. Platinum can be made extremely hot without melting or burning. It can be used for dishes and containers in which to put materials that are so hot they would melt glass. Some substances, like ammonia and oxygen, will combine more easily if there is a piece of platinum present than if there is none.

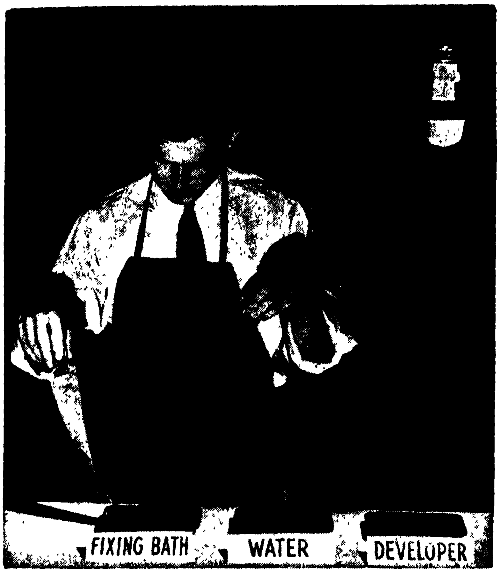
Silver is usually obtained from an ore containing the compound silver sulfide, or from an ore containing silver chloride. Quite large quantities of these ores are found in the United States, in Colorado; some of the

GOLD FOR MANY DIFFERENT USES



Courtesy, Handy & Harman, N Y

Karat gold of many shapes and sizes, ready for shipment. A "karat" is 1/24th part by weight of gold in an article



The silver bromide on film blackens when developed.

mountains of Mexico also have large quantities of silver ores. If the chloride is treated with another metal, mercury, the mercury combines with the chlorine and sets the silver free. Silver is used for making jewelry, table silver and coins. You have probably noticed that silver objects tarnish, that is, turn black, very readily. That is because there are very small amounts of hydrogen sulfide in the air. The silver removes the sulfur from this hydrogen sulfide, forming black silver sulfide.

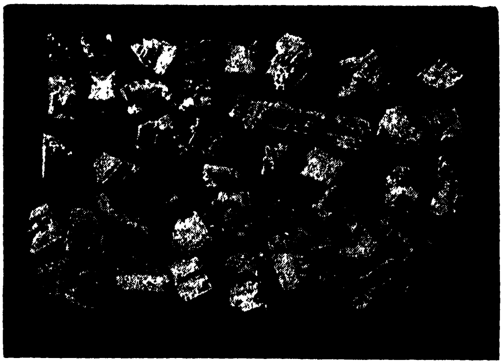
Large amounts of silver chloride and a similar compound, silver bromide, are used in photography. The solution, called a developer, that is used in photography will change either silver chloride or silver bromide to small black particles of silver. But if a paper or a film coated with a little silver bromide or silver chloride has light shine on it, the places where the light was brightest will be changed by the developer most quickly. The paper or film can be left in the developer long enough so that all the places where the light shone have been changed to black silver, and none of the places where there was no light have changed. Then the silver chloride or silver bromide that was not in the light, and has not changed to silver, is dissolved off by putting the paper or film in another solution called a "fixer." You then have a "negative," a paper or film that is dark where the light shone on it and white where there was no light.

After that you can hold the film negative over another piece of paper coated with silver chloride or silver bromide and shine light through the film upon the paper. Then if the paper is put in the developer and fixer, the parts where the light came through the negative will turn dark and the parts where the negative was dark and the light did not come through will stay white. So the paper is lightest in the places where most light originally fell on the film and you have a photograph.

We mentioned the metal mercury when we were describing how silver can be obtained from an ore. Mercury is an unusual metal, because it is the only metal that is a liquid. It is used in the thermometers with which doctors and nurses take sick people's temperatures. Perhaps you have been around when one was broken and watched the little silvery drops of mercury run around all over a table or the floor. Because it is so bright and so hard to pick up, some people call it quicksilver.

The ore from which mercury is obtained contains mercury sulfide, a bright red compound that is often called "vermilion." If this ore is heated in a stream of air, the sulfur combines with the oxygen to form sulfur dioxide and leaves pure mercury behind. The sulfur dioxide is a gas that is carried away with the air. In addition to being used in thermometers which measure temperature, and in barometers which measure pressure, mercury is used in all kinds of electrical gadgets, for it conducts an electric current very well. It combines with chlorine to form two chlorides, one of which, calomel, is a medicine, and the other is extremely poisonous. The sulfide that is called vermilion is used to make red paints.

Two other metals that do not look very



Courtesy, Diamond Crystal Salt Co., Inc.

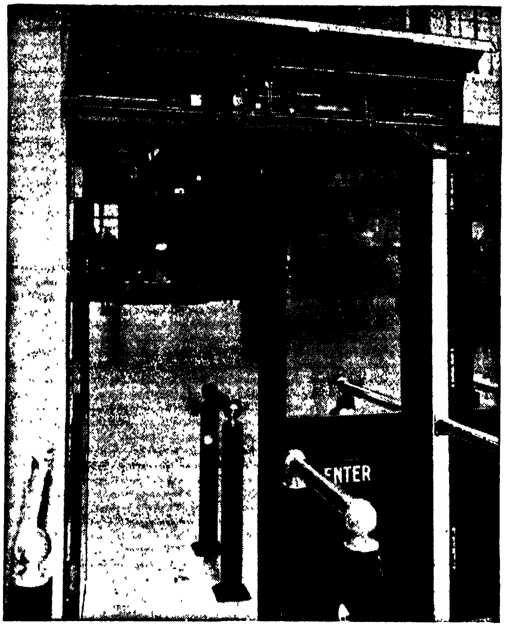
Crystals of sodium chloride, which is common table salt.

much like metals are sodium and potassium. Unlike the noble metals, they are extremely active. When you first make them they are shiny, but so soft you can cut them with a knife. But if you let them stay in air, they immediately change to a white powder; they have combined with the oxygen and the small amount of dampness that is always present in air. If you put them in water, they are so light they stay on top instead of sinking; and they immediately start to hiss and form bubbles of gas, and slowly disappear. While they are doing this, they get very hot. The potassium gets so hot it bursts into flame and makes a pretty violet light. If you collect some of the gas that is forming you find it is hydrogen. The sodium and potassium combine with the oxygen and part of the hydrogen in water to form sodium hydroxide and potassium hydroxide. The rest of the hydrogen is set free. You do not see the hydroxides because they dissolve in the rest of the water.

As you can imagine, elements as active as sodium and potassium are found only in compounds, and they are rather difficult to obtain from these compounds. The best way to make them is to pass an electric current through some compound that contains them. Two things make this more difficult than it sounds. One is that in order for a current to pass through these compounds, they have to be either melted into a liquid or else dissolved in water. But if they were dissolved in water, the sodium or potassium would immediately react with the water. So they have to be melted. But these compounds will not melt unless they are extremely hot. However, if sodium or potassium hydroxides are melted, and an electric current passed through the liquid, the metal—sodium or potassium—is formed where the current enters the liquid. The sodium or potassium melts in this great heat, and floats on top of the liquid hydroxide in silvery globules that look like mercury.

TABLE SALT CAN BE BROKEN DOWN INTO SODIUM AND THE POISON GAS CHLORINE

Another substance from which sodium can be formed is ordinary salt. The salt is mixed with another white powder, calcium chloride; then it can be melted at a temperature lower than would otherwise be needed. When the electric current is passed in, silvery globules of sodium form around one wire and a greenish yellow gas, chlorine, is formed around the other wire. (The chlorine and the sodium have to be kept apart from each other; if they were not, they would combine very violently with each other, forming salt again.) This way of making sodium shows that salt is a compound of two elements, one the poison gas, chlorine, and the other the metal, sodium, that reacts so violently with water and burns so readily in air. And yet salt, itself, is actually quite an inactive substance, not in the least poisonous!

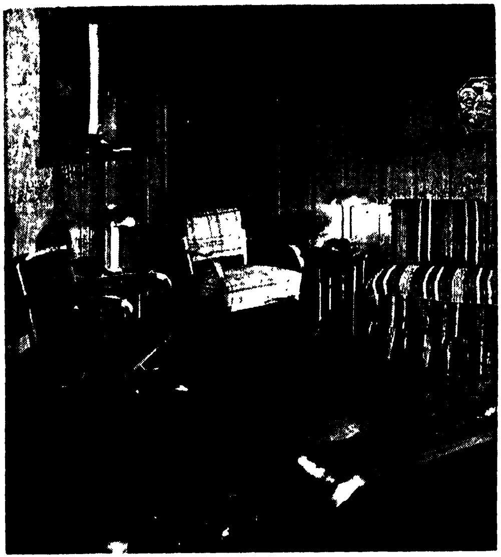


Courtesy, The Stanley Works

Potassium at work, in an "electric eye" device which opens doors automatically in this railroad station.

These two metals—sodium and potassium—are more curious than useful. If they are to be kept at all, they must be protected from air and moisture by being kept under kerosene. Since they combine with oxygen so eagerly, they can be used to remove oxygen from other metal oxides and leave the other metal free. But since sodium is so expensive to make and so hard to keep, it is used for this only if cheaper substances, like carbon, will not do the same thing. Have you ever seen a door opened by an "electric eye," or photoelectric cell? Then you have seen potassium at work, for potassium is needed to make these electric eyes.

Your mother probably has saucepans of aluminum. This is the most plentiful metal in the earth; but it is found only in compounds from which it is difficult to get the aluminum free. Clay is a compound that contains aluminum; aluminum oxide is another. There are several forms of aluminum oxide. Hydrated aluminum oxide is called bauxite; if it is dark colored, it is called emery; and if it looks like beautiful blue or red crystals, we recognize it as the precious jewels known as sapphires or rubies.



Courtesy, Aluminum Company of America
Aluminum furniture is good looking and easy to clean.

It was only about a hundred years ago that the first pure aluminum was made. The only way to get it in those days was by treating an aluminum compound with sodium. But sodium is so hard to make that it is no wonder aluminum was more costly than gold. However, men thought that if they could pass an electric current through an aluminum compound, aluminum could be made very much less expensively. About the only compound that could be used was aluminum oxide, and that could not be made hot enough to melt. Finally, about 1886, a young man, Charles Martin Hall, discovered that aluminum oxide would dissolve in cryolite. This is a substance that comes from Greenland but nowadays it is made artificially. Since then, aluminum has been made cheaply by passing an electric current through the liquid mixture of these two substances. The aluminum oxide is broken up into aluminum and oxygen.

Once aluminum could be made easily, it became a very useful metal. Like most metals it combines with oxygen to form aluminum oxide. In fact, powdered aluminum will burn with a bright flame in oxygen. But at ordinary temperatures, in air, it combines with oxygen very slowly. A shiny aluminum surface becomes slightly dull because the oxide has formed on it; but this layer of oxide on the surface is a hard, firm coat that prevents the air from getting at the aluminum underneath. Things that are made of aluminum will not fall to pieces as they get old, since underneath the top layer the aluminum does not continue to oxidize. Heat and electricity pass through aluminum easily. We say aluminum is a good conductor. It does not conduct quite so well as silver, gold and copper. But since silver and gold are very expensive, and pots made of copper are much heavier than pots made of aluminum, you will find pots and saucepans of aluminum in most kitchens. The heat from the stove passes quickly through the aluminum to the food inside, cooking it quickly.

Perhaps you remember, or have heard people say, that during the war saucepans and other articles made of aluminum were hard to get. This was because a great deal of aluminum goes into the making of an airplane. Aluminum is so light that it would be ideal for making planes, except that aluminum alone is not quite strong enough. If it is mixed with other metals,

Courtesy, Aluminum Company of America
Aluminum jewelry is cheerful and has a pretty luster.

it can be made stronger without getting too heavy to be used. Mixtures of metals are called alloys. One alloy that is used for planes is called Duralumin and contains, in addition to aluminum, small amounts of copper and of a third metal, magnesium. It is interesting to think what would have happened if Hall had not discovered a cheap way to make aluminum. Possibly the planes in use today would be very different in construction, and perhaps there would not be such big ones.

If a mixture of powdered aluminum metal and iron oxide is heated slightly, the aluminum will combine with the oxygen of the oxide, leaving the iron free. When this happens, the mixture gets extremely hot, so hot that the iron melts. Because it produces so much heat, this mixture of iron oxide and aluminum is called thermite. Broken iron rails or bars can be mended if a mold of the right shape is placed around the broken part and a container of thermite is used to make liquid iron above the mold. The iron will run down into the mold, and after it has cooled and become solid the broken parts will have been joined.

Of all the many metals, iron is the most used. A hundred million tons of it are made every year. There is almost as much iron in the earth as there is aluminum. Although iron is found only in compounds, it is far easier to obtain iron from its compounds than to get aluminum. In fact, people knew how to get iron five thousand years ago. The compound that is used is a red ore that is called rust, or iron oxide. The best way to get the iron is to heat the oxide with coke. The carbon in the coke combines with the oxygen, forming carbon monoxide gas which goes off into the air, leaving liquid iron. This is then poured into molds to cool into cast iron.

Cast iron contains small quantities of other substances, carbon from some of the coke that was not used up, and other nonmetals that were present in the iron-oxide ore. These impurities make the cast iron too easy to break. It can be used for radiators and stoves, but not for bridges and cars that have to support great weight. For those we need treated iron—steel. Steel is made by pouring liquid cast iron into a furnace and blowing blasts of air through, to burn out the carbon and other impurities. Then, since absolutely pure iron is not strong either, an alloy of iron and carbon and another metal, manganese, is added in just the right amount to make good steel.

In the last fifty-odd years, a great many kinds of special irons and steels have been made for special purposes by adding small amounts of other substances to iron or to

Courtesy, Eastern Stainless Steel Corporation

A cafeteria made of stainless steel. This metal is made by mixing one part of chromium with four parts of steel.

steel. You have probably seen knives of "stainless" steel, that is, steel that does not rust. This is steel that is only about four-fifths iron; the other fifth is the metal chromium, that prevents the steel from rusting. Tungsten is a metal that is used to make the wire inside electric light bulbs. When one pound of tungsten is added to nineteen pounds of steel, you have a very hard alloy. This is used to make tools for cutting parts for machines. At least eighty-five special kinds of iron and steel have been found useful! Each one is an alloy of iron with different amounts of other metals or non-metals.

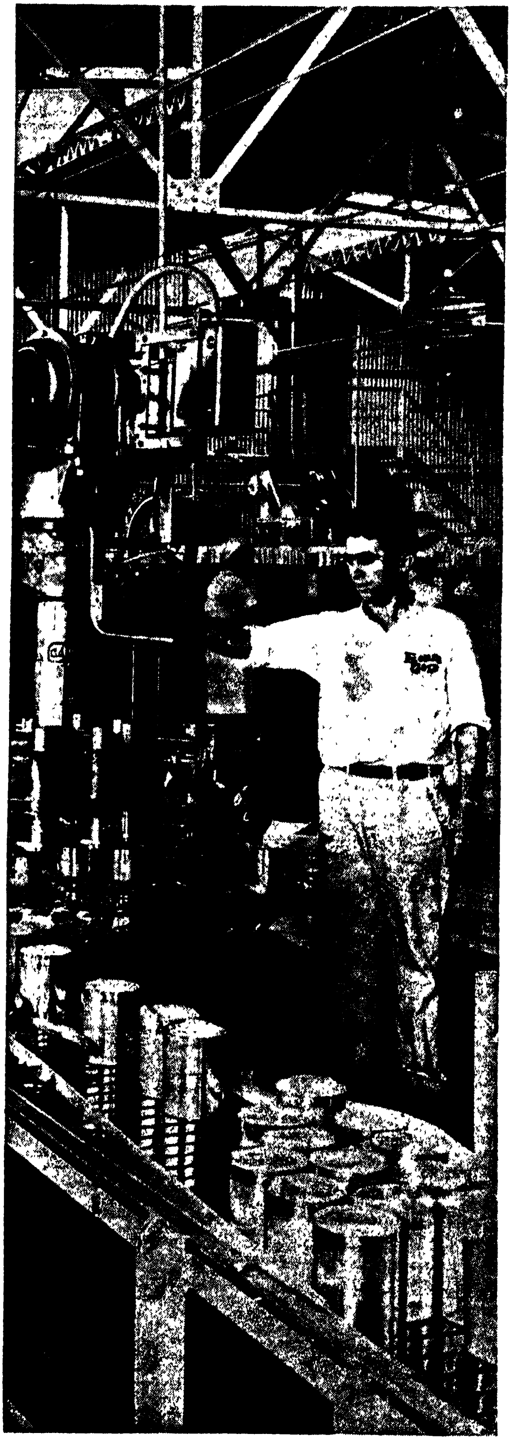
Some compound of iron has to be present in small quantities in our food. It is needed to form the compound that gives blood its red color. If a person does not have enough of it in his blood, he can not make proper use of the oxygen in the air he breathes, and he will not have very much energy. He will look pale, and the doctor will say he is anemic.

Iron is less active than sodium and potassium, but it is still quite active. It combines slowly with oxygen to form oxides, one of which is rust, as we have seen. Iron also combines with chlorine to form chlorides and with sulfur to form sulfides. If it is put into sulfuric acid, bubbles of the gas hydrogen form. That means that the iron sets free the hydrogen from the acid. The iron itself dissolves.

HOW WE OBTAIN AND USE THE COMMON REDDISH-GOLD METAL WE KNOW AS COPPER

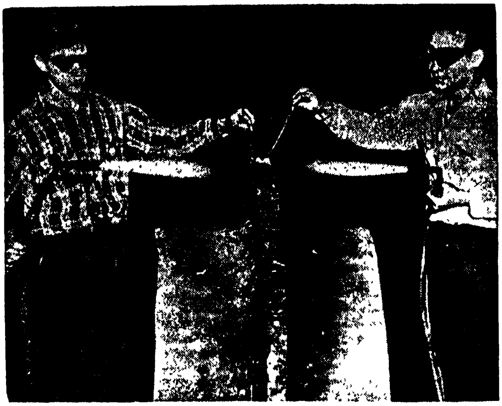
Copper is a metal both useful and beautiful. It has a lovely red-gold color and can be used for making ornaments and jewelry. It conducts electricity so well that almost all electric wires are made of copper. In Michigan, rocks are found that contain free copper. It is obtained from the rocks by crushing and heating them; the copper melts and flows away from the rest of the rocks. It is also found in ores with sulfur—copper sulfides. When these sulfides are heated in air, the sulfur combines with the oxygen of the air and forms the gas sulfur dioxide. The hot copper that remains combines with more oxygen to form copper oxide. Then the copper oxide has to be heated with carbon, in the same way that iron oxide is, before the copper metal can be obtained free.

Copper is not quite so active a metal as iron, although it is more active than the noble metals—silver, gold and platinum.



Courtesy, American Can Company

Closing cans in a fruit cannery. Tin cans are really made from steel that has been thinly coated with tin.



Courtesy, Handy & Harman, N. Y.

Metals being brazed, or joined, with a silver alloy.

When it is cool, it combines very slowly with oxygen, forming a black powder. If it is hotter, the oxide forms more readily. It will burn in chlorine to form a chloride. This copper chloride is a blue powder that makes a bright blue solution if it is dissolved in water. Copper will also combine with sulfur to make a black, powdery sulfide. If copper is put into sulfuric acid, however, it will not free hydrogen from the acid.

Chemists sometimes speak of the rare-earth metals. The term refers to a group of fourteen different metallic elements, from atomic number 58 through number 71. Each of these elements is very similar to the others in physical and chemical properties. The reason for calling them rare-earth metals is that a long time ago the substances in which they were found resembled what was known in that time as earths (lime, magnesia and so on). The metals were obtained from these substances in small quantities.

One of the very rarest metals in the world is radium. In fact, the pure metal has been prepared only once, by Madame Curie. Compounds of radium, such as radium chloride, can be prepared in very small quantities. The radium in these compounds is continually giving off large quantities of invisible rays. These rays are helpful in curing some skin diseases and some kinds of cancer.

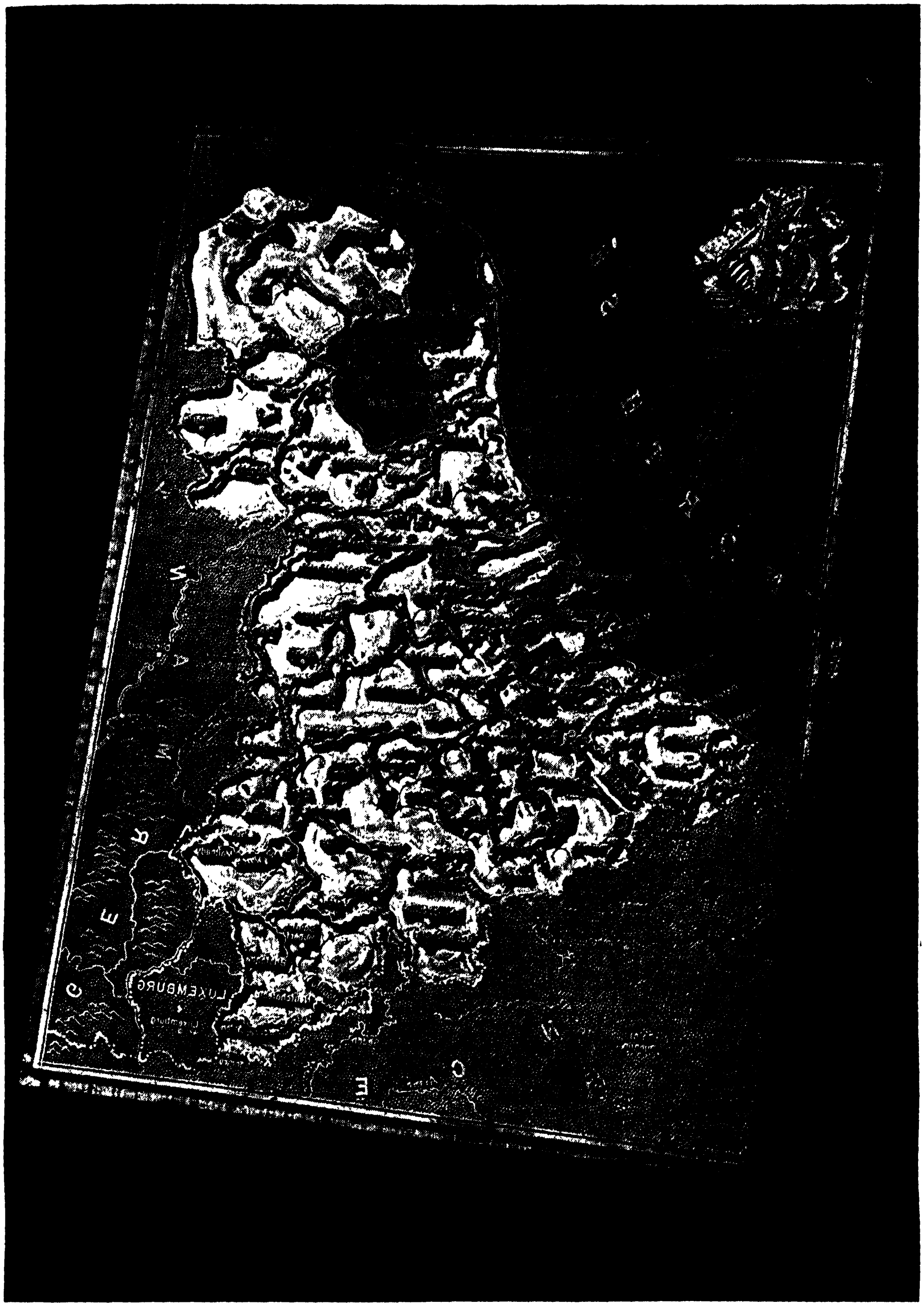
In trying to explain the way in which metals and non-metals combine with each other to form compounds, and the way in which radium produces rays, we must go back to the atoms and their parts, the protons and electrons and neutrons. The protons and neutrons are in the center of each atom, and the electrons move in rings around the center. Atoms of elements can share some of the electrons in their outer rings. In this way the elements combine to form compounds. For instance, when sodium and chlorine combine to form salt, each atom of sodium shares one of its electrons with a chlorine atom. Metals are made of atoms that readily share electrons, and non-metals are made of atoms ready to gain electrons. For this reason, metals and non-metals combine readily with each other to form compounds. Yet it is always possible for the metal to get its electrons back, either from another element or from an electric current. Then the compound breaks up and the free metal is formed again. An electric current is believed to be a stream of free electrons flowing along a wire, drifting in and out between the atoms that make up the material of the wire. Non-metals would rather gain electrons than give any up, or allow any to drift by. So non-metals are not good conductors.

SOME ELEMENTS LEAD SUCH A STRANGE LIFE THAT THEY CHANGE INTO NEW ELEMENTS

The atoms of a few elements act quite differently from the atoms of most other elements. Radium is one of these. In addition to losing electrons to form compounds, the atoms of radium are continually losing protons and neutrons. We say they are radioactive. When they lose protons and neutrons, the atoms are not radium any more, but atoms of some other element. As a first step, the radium atom loses two protons and two neutrons and becomes an atom of a gas, radon. Then the radon atom loses protons and neutrons, until, after the original radium atom has lost ten protons, ten neutrons and four electrons, an atom of lead is formed. This lead atom will not change any more. The protons, neutrons and electrons given off while the radium atom is changing to lead, make the rays that can be used for curing diseases. We tell you more about this strange life-history of some elements in the chapter on Radioactive Elements.

Uranium is a radioactive metal. In fact, all radium atoms were originally formed from uranium atoms after the uranium atoms had lost six protons, six neutrons and two electrons. Ordinary uranium is not so useful as radium, because it forms rays so much more slowly than radium does. But there is a special kind of uranium whose atoms contain three less protons than ordinary uranium

A METAL HELPS TO PRINT THIS BOOK



A zinc plate used to print page 5494 of THE BOOK OF KNOWLEDGE. Copper is also used in printing plates. Other metals, too, such as lead, antimony and tin, play their parts in bringing you these words and pictures.

atoms. It is even rarer than radium, but during the war ways were found for separating these special uranium atoms from ordinary uranium atoms. The special uranium atoms, instead of giving off a few neutrons and protons, can be made to split into two parts; in doing this they give off great energy. So this special uranium was used in the atomic bomb that helped us to end the war against Japan.

By Phyllida M. Willis.

THE NEXT STORY OF SCIENCE IS ON PAGE 5797.

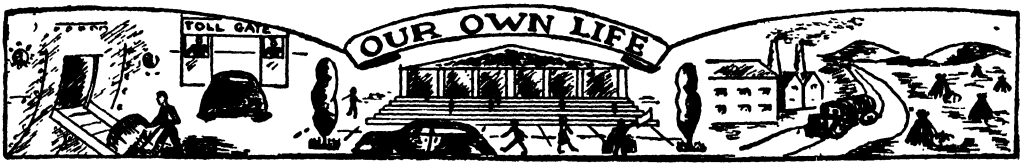
TABLE OF ELEMENTS SHOWING METALS AND NON-METALS

METALS

Name	*Symbol*	*Usual Form*
Actinium	Ac	Solid
Aluminum	Al	Solid
Americium	Am	Solid
Antimony	Sb	Solid
Astatine	At	Solid
Barium	Ba	Solid
Beryllium	Be	Solid
Bismuth	Bi	Solid
Cadmium	Cd	Solid
Calcium	Ca	Solid
Cerium	Ce	Solid
Cesium	Cs	Solid
Chromium	Cr	Solid
Cobalt	Co	Solid
Columbium	Cb	Solid
Copper	Cu	Solid
Curium	Cm	Solid
Dysprosium	Dy	Solid
Erbium	Er	Solid
Europium	Eu	Solid
Francium	Fa	Solid
Gadolinium	Gd	Solid
Gallium	Ga	Solid
Germanium	Ge	Solid
Gold	Au	Solid
Hafnium	Hf	Solid
Holmium	Ho	Solid
Indium	In	Solid
Iridium	Ir	Solid
Iron	Fe	Solid
Lanthanum	La	Solid
Lead	Pb	Solid
Lithium	Li	Solid
Lutecium	Lu	Solid
Magnesium	Mg	Solid
Manganese	Mn	Solid
Mercury	Hg	Liquid
Molybdenum	Mo	Solid
Neodymium	Nd	Solid
Neptunium	Np	Solid
Nickel	Ni	Solid
Osmium	Os	Solid
Palladium	Pd	Solid
Platinum	Pt	Solid
Plutonium	Pu	Solid
Polonium	Po	Solid
Potassium	K	Solid
Praseodymium	Pr	Solid
Promethium	Pm	Solid
Protoactinium	Pa	Solid
Radium	Ra	Solid
Rhenium	Re	Solid
Rhodium	Rh	Solid
Rubidium	Rb	Solid
Ruthenium	Ru	Solid
Samarium	Sm	Solid
Scandium	Sc	Solid
Silver	Ag	Solid
Sodium	Na	Solid
Strontium	Sr	Solid
Tantalum	Ta	Solid
Technetium	Tc	Solid
Terbium	Tb	Solid
Thallium	Tl	Solid
Thorium	Th	Solid
Thulium	Tm	Solid
Tin	Sn	Solid
Titanium	Ti	Solid
Tungsten	W	Solid
Uranium	U	Solid
Vanadium	V	Solid
Ytterbium	Yb	Solid
Yttrium	Y	Solid
Zinc	Zn	Solid
Zirconium	Zr	Solid

NON-METALS

Name	*Symbol*	*Usual Form*
Argon	A	Gas
Arsenic	As	Solid
Boron	B	Solid
Bromine	Br	Liquid
Carbon	C	Solid
Chlorine	Cl	Gas
Fluorine	F	Gas
Helium	He	Gas
Hydrogen	H	Gas
Iodine	I	Solid
Krypton	Kr	Gas
Neon	Ne	Gas
Nitrogen	N	Gas
Oxygen	O	Gas
Phosphorus	P	Solid
Radon	Rn	Gas
Selenium	Se	Solid
Silicon	Si	Solid
Sulfur	S	Solid
Tellurium	Te	Solid
Xenon	Xe	Gas



BANKS AND BANKING

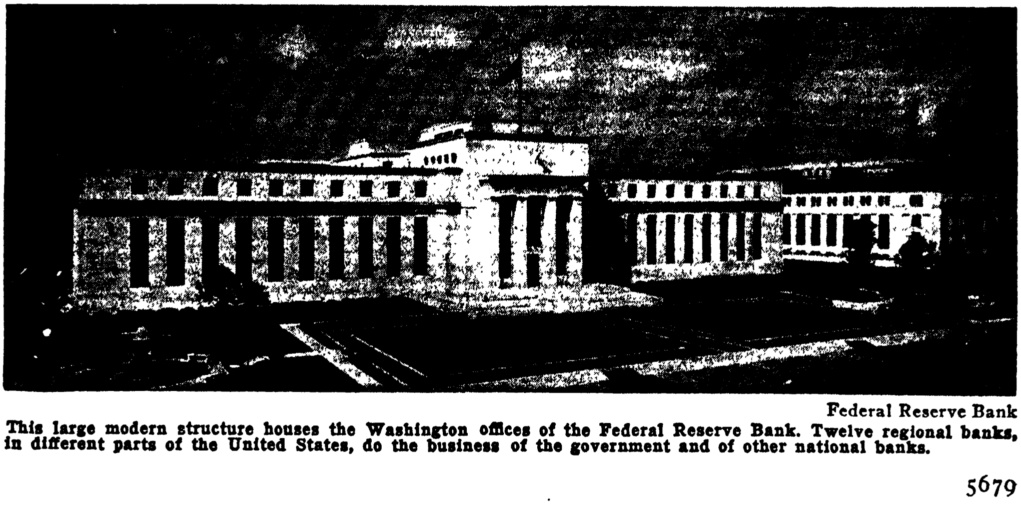
EVERY one of you has seen at least the outside of a bank. Perhaps you have wondered what went on behind the doors. We tell you here of the banks in former times, and then of the different kinds of banks today. We tell you what the ordinary commercial bank does and how banks in Canada and the United States differ. In Canada there are only ten banks, but they have hundreds of branches, some in very small towns or even in the rural districts. In the United States the independent bank is more common. In fact, there are about 15,000 banks in the United States, some very large, and others quite small. In some states banks are forbidden to have branches; in others branch banking is permitted. Some of the banks in the United States are supervised by the national government and others by the states. We also tell you of trust companies and of savings banks; we show you some interesting pictures of safe deposit vaults, where valuables may be kept. You will find some pictures of bank locks on pages 2025 and 2026. The story of locks is an interesting subject in itself.

In almost every town in Canada and the United States you will find at least one bank. In the larger towns and cities there are many, though some seem to have the same name. In a small town the bank may occupy only one or two rooms and employ only two or three people; in a city, banks often occupy imposing buildings and employ hundreds of people.

What is the purpose of a bank and how is it conducted?

In olden times in the trading cities of Italy, men from every part of the world came, bringing with them the coins of their countries, and, sometimes, bars of gold or silver. There were men who engaged in the business of changing this money into the money of the city. Each of these money-changers sat at a bench or table (*banca* in Italian) and this may be the origin of our word bank.

To protect their money from thieves, strong boxes and secret vaults were commonly used by the money-changers. Knowing this, other people who had saved up some money would pay the money-changers to keep it for them in the vaults. Since these "depositors" seldom took back all of their funds at one time, there would be a balance at the end of each day. The money-changers soon realized that extra profits could be made by loaning out these reserves, or bal-

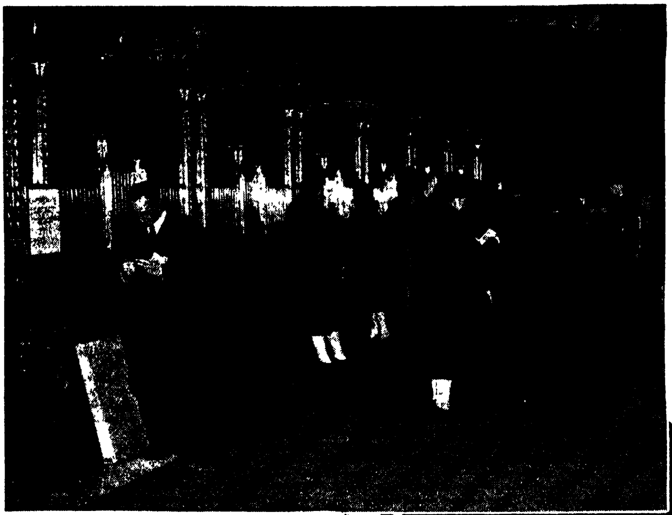


Federal Reserve Bank

This large modern structure houses the Washington offices of the Federal Reserve Bank. Twelve regional banks, in different parts of the United States, do the business of the government and of other national banks.

ances, at interest, upon good security. This was the beginning of the modern bank that today accepts deposits and makes loans.

The individual banker is not common now, and the modern bank does many things of which the banker of the Middle Ages never dreamed.



Interior of a bank. Many services are rendered by banks. Besides furnishing a safe place for keeping your money, banks have vaults where valuables may be kept in strong boxes.

Both pictures, courtesy Union Dime Savings Bank of New York

Cashiers and tellers tend to much of the business of a bank. Wonderful machines help them in figuring. One machine "gobbles up" a quantity of various coins, sorts them and counts the total, all in the twinkling of an eye.

There are several different kinds of banks in the United States, but the ordinary commercial bank is the most important. It is organized either as a national bank with a charter from the Federal government, or as a state bank chartered by the state in which it is located.

The owners of a bank are called shareholders because they own shares of stock in it, for which they usually pay around $100 per share. These shareholders meet every year and elect a certain number of men who are called directors. These directors are responsible for the general management of the bank. They, in turn, select the officers who actually conduct the business of the bank, which is often a very complex matter.

Every commercial bank, no matter how small, performs many important services to both business men and their families. First, it receives money from its customers which it promises to keep safely, and to pay the whole or any part upon a written order. If your father buys a load of coal for the furnace, he is likely to pay for it with one of these written orders, called a check. When he pays the month's rent or the yearly taxes on your home, he will probably pay by check. In fact, many people pay nearly all their bills in this way, because it is more convenient and safer than to carry large amounts of cash around in one's pocket. The bank furnishes every customer with a book of blank checks, bearing the name of the bank. For these he may have to pay a small sum.

The one receiving the check may take it to the bank and cash it; that is, receive the money, provided he is known by the bank; or perhaps he will write his name across the back and give it to someone to whom he owes money. Sometimes he may have an account in the same bank and will take or send it to the bank and ask to have the amount added to his own account.

This is easy if all the checks are drawn upon the same bank. It is very possible, however, that a customer may deposit several checks, each drawn upon a different bank in widely scattered towns or cities.

The bank will collect these checks for its customer. It may, or may not, charge a small collection fee. Checks drawn upon banks in the same town are not much trouble. If there are only a few banks in a town, a clerk may take all the checks to the other banks and collect them.

This method of collection is not possible in larger cities with many banks. So there is a clearing house where representatives of each bank come together at a stated time at least once a day to exchange checks and pay any differences.

The problem of collecting checks becomes far more difficult when they are on out-of-town banks. There are many checks of this kind, since it is common for people to draw checks on their local bank with which to pay debts owed in other places. For example, suppose your father draws a check upon the national bank in the town in which you live, say, Ypsilanti, Michigan, to pay for a year's subscription to a magazine published in New York. Upon receiving the subscription, the New York publisher writes his name on the back of your father's check and deposits it with his bank for collection. That bank at once sends it to the Federal Reserve Bank (to be described later) in New York. The Federal Reserve Bank in New York will in turn send it to the Federal Reserve Bank in the district where the Michigan city is located, which is the Chicago Federal Reserve Bank. The check is then returned to your bank in Ypsilanti, and the amount is next deducted from your father's account.

U. S. Trucking Corp.

Money is transported to and from banks in an armored car. Here you see armed guards convoying a money shipment.

What is to prevent a man from writing a check upon a bank in which he has no money or too little to pay the check? Nothing, except his own honesty and fear of punishment. To avoid this danger, sometimes a "certified" check is demanded. This is a check upon which the word CERTIFIED is stamped or written above the signature of a bank official. This means that the bank guarantees to pay the amount when the check is presented.

Keeping your money safely and collecting checks cost the bank something. It must have a banking house fully equipped with furniture and expensive safes; it must have employees called tellers to receive and pay out money and clerks to keep the accounts. There are many other expenses—for printed matter, lighting and telephones, and so on. How can a bank afford to provide all these services for its customers?

The answer is by making loans—the second major function of a bank. Perhaps a man needs money quickly because of illness or accident in his family. Perhaps a manufacturer wishes to buy large quantities of raw material because it is cheap at the time; or perhaps a farmer needs money to buy seed and some new tools in the spring or to employ farm hands to help harvest the crop in the fall. For these or other reasons a man may go to a bank to borrow money. If the loan is granted he signs a "note," which is simply a promise to pay the sum back with interest at some fixed date in the future.

Sometimes a man who is known to be honest, who has property or a good position, may borrow on his own promise to pay. Often a bank will ask to have a relative or friend indorse the note, that is, write his name across the back. This means that the second person is responsible if the first fails to pay. However, most loans are made upon security of some sort. Suppose a store in your town had a carload of furniture coming from the wholesaler for which the store owner must pay cash when it arrives. He may take the receipt from the railroad (called a bill of lading), showing that the goods are on the way, to the bank, and borrow a part of the value of the furniture, agreeing to repay the bank as he sells the furniture. Perhaps a farmer buys cattle in order to fatten them for the butcher. He needs to borrow a part of the cost. This he can do, using the cattle as security.

Federal Reserve Bank of New York

These heavy gold bars are being carefully weighed by bank employees. Gold itself is no longer used as a medium of exchange, but many thousands of dollars of depositors' money may be represented here.

Often a man who has stocks or bonds greater in value than the amount of money desired may use those as security. He will take them to the bank and sign a paper giving the bank the right to sell his stocks and bonds and pay itself from the money received, if his note is not paid when due. If the note is paid, the stocks or bonds are returned to their owner. Even good real estate and life-insurance policies may be used to secure bank loans.

Whose money does the bank lend? The answer is—both its own and some of that belonging to its depositors. We have already seen that the owners, that is, the shareholders, had to pay for their shares of bank stock before the bank could open up for business. This is called the bank's capital. As years go on, the bank does not pay all its profits to the shareholders, but builds up a surplus. In many banks the surplus is far greater than the original capital. The capital and surplus belong to the shareholders, and it is loaned out at interest.

The depositors' money is also loaned out. The bank promises to pay any depositor's money whenever he asks for it. If it can not do so, the bank is not allowed to continue in business. How, then, can it loan this money, which may be asked for at any moment?

The reason is simple. Unless the bank is expected to fail, all depositors do not want all their money at once. Every day money is being deposited as well as being drawn out. Then, too, we told you above, very often the man to whom your father gave a check uses the same bank and deposits the check to his account, and no money leaves the bank at all. At the end of the day there is usually about as much money in the bank as there was in the morning.

Long experience has shown that if the bank keeps a small portion of its deposits on hand—say ten or fifteen dollars of every hundred—it will be able to pay all checks that are presented. Naturally, this means that the bank must be very careful about its loans. It must not make a loan unless it is certain beyond all reasonable doubt that it will be paid promptly. Moreover, it must not make loans for too long a period. Usually loans must be repaid in from thirty to ninety days.

Banks render many other services in addition to accepting deposits and making loans. These include buying and selling stocks and bonds upon order, providing financial information for customers, selling checks on a bank in a foreign country, or collecting money due you in foreign countries. Banks will buy and sell money for you, issue letters of credit which instruct foreign banks to pay money up to the amount stated in the letter, and sell you travelers' checks which are accepted the world over. They also rent safety-deposit boxes in which you may keep important papers and other valuables.

The independent savings bank is popular in the United States. It is not at all like the bank we have described. Savings banks are organized to help people become thrifty. They provide the small saver with a safe place to keep his money, and they pay a small interest for the use of the money. The money deposited is expected to remain some time, and some banks receive as little as five cents. Many people deposit a part of their wages or salaries every week or month. These deposits are loaned upon mortgages on real estate, or high-grade bonds are bought. Savings banks are not allowed to make business loans or to carry checking accounts.

These banks have no shareholders but are owned by the depositors and managed by a board of trustees, elected by them. The profits, after expenses are paid, are added to the accounts of the depositors according to the amount each has in the bank. This may be done every three months. For example, if you have a hundred dollars in the bank for three months, and the profits are at the rate of two per cent a year, one-fourth of this, or fifty cents, will be added to your account. During the next three months you will get interest on this $100.50, and this interest will again be added to your account. This is called compound interest. While there are only about 550 of these banks they have savings deposits of over $10,000,000,000.

Commercial banks have generally added savings departments, but the accounts are kept separate from other accounts. Your father may have both a savings and a business account in the same bank. Usually the savings bank will allow you to draw out your savings at any time, but, if they wish, the managers may require you to give notice in advance.

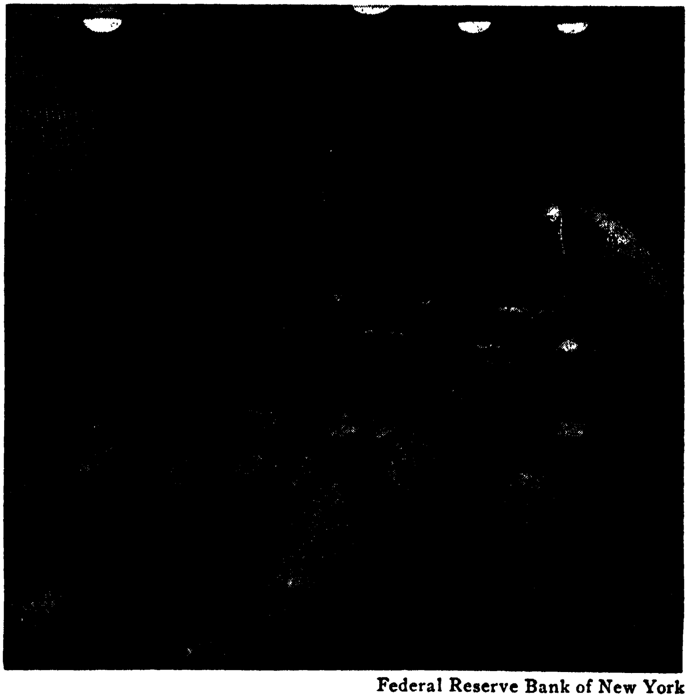
Trust companies have come to be considered as banks, since most of them do a commerical banking business, and most commercial banks do a trust business. Trust companies are organized to act as trustees, and can do everthing an individual trustee can do. They may manage estates; look after property, collecting rents and paying bills; act as executors of wills; as managers of funds left in trust for particular purposes; or as guardians of young children or persons unable to manage their own affairs. When a business fails they may take charge of the interest of the creditors, to whom the bankrupt business owes money. They perform many other services.

There is another kind of bank which should be mentioned. This is the Postal Savings Bank, which is under government control and operated through the United States Post Office.

Because banks loan out great sums of money that have been deposited with them by large numbers of people, every state as well as the United States carefully controls and supervises the things which banks may do. Otherwise your father, along with many others, might lose the money he has been saving in order to send you to college, to build a new home, to buy a new car or to support him in his old age.

The United States Government regulates, supervises and assists all national banks through the Federal Reserve System. At the head of the system is a Board of Governors, in Washington. The country has been divided into twelve banking districts, and in each one is a Federal Reserve Bank, through which the Board of Governors work.

These are bankers' banks. They neither take deposits from individuals nor make loans to them. Their only purpose is to regulate and assist all national banks and those state banks which have joined the Federal Reserve System. These member banks must keep certain reserves in the Federal Reserve Banks, and when in need of additional money they may borrow it from the Reserve



Federal Reserve Bank of New York

These gold bars will be listed and stacked like books in a library.

Banks. These twelve bankers' banks also do the Government's banking business. It is very important to remember that these are the only banks in the United States that issue money. The money they issue is in the form of Federal Reserve Notes.

While slightly less than half of the 15,000 banks in the United States belong to the Federal Reserve System, they are by far the largest and most important banks, and hold most of the people's money.

As a further protection, the Federal Deposit Insurance Corporation guarantees deposits placed in banks that have joined this corporation, up to $5,000. All national banks and many other banks belong to this insurance plan.

Except in a few states there are not many branch banks in the United States. In fact, some states forbid branch banking entirely; and where branch banking is permitted the independent bank is more common, except in a few large cities.

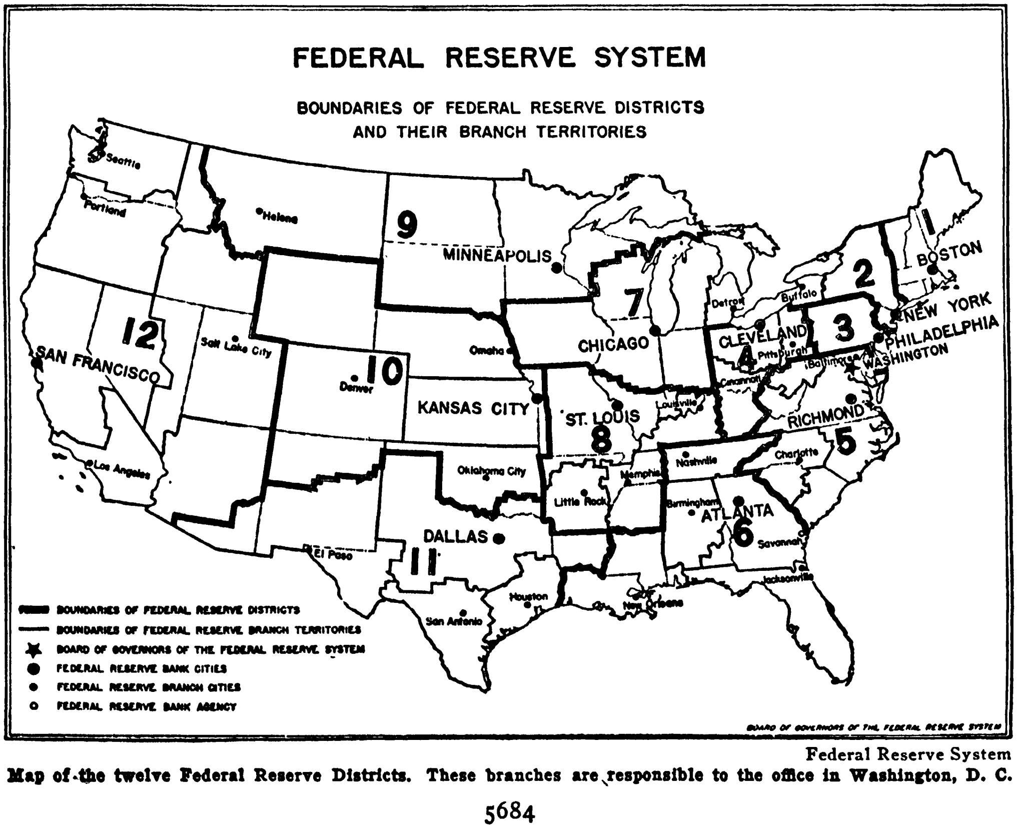
In Canada, banking is carried on in very much the same way as it is in the United States. The commercial banks accept deposits upon which checks (spelled cheques in Canada) may be drawn; and they make loans. While there are a few savings banks, the savings departments in the commercial banks do a larger business. Trust companies, unlike those in the United States, are not allowed to carry on general banking.

There are only ten large independent commercial banks in Canada, with about 300 branches within the country and 150 in foreign countries. Because of the many branches within the country, cheques are usually collected through the head office or through a branch in the nearest large city where there is a clearing house. Unlike banks in the United States, the Canadian banks may not make loans on real estate.

Now many years ago the Bank of Canada was organized, with powers very much like those of the Federal Reserve Banks in the United States. It, too, takes deposits only from other banks and from the Government. The sole power to issue notes now belongs to this central bank.

By Graeme O'Geran.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 5929.



Federal Reserve System

Map of the twelve Federal Reserve Districts. These branches are responsible to the office in Washington, D. C.

For Sale — Dragon's Breath, Cheap

By Elizabeth Foreman Lewis

One evening, as the Chinese boy Young Fu returned early from the last errand of the day, Tang dismissed him with the suggestion that he go play a little. Surprise at this unexpected freedom held the apprentice motionless for a moment, then he folded his leather apron, laid it away, and passed into the street. For lack of something more exciting to do, he directed his steps toward Thief Street. The stolen goods, displayed there on the open stalls, offered nothing of unusual interest, and it was not until he had turned into one of the larger business thoroughfares that evil fortune gripped him.

There, in a jeweler's shop, hung a shining, nickel watch, large and round and, strange to say, black of face. Young Fu had seen several watches in his lifetime, but never one with a dark face. He stopped and studied it. Then, following his fate, he had crossed the sill and asked the proprietor to tell him the reason for such a color.

Hsui, the jeweler, was stout and prosperous, with all of the tricks of the trade at his command. "I do not recognize you," he began, "but you are a young man of very great acumen. That valuable treasure has been hanging there on display for three days, and you are the first with sufficient intellect to note its extraordinary appearance."

This opening at once knocked down all the defenses which the youth might normally have had in the presence of a shopkeeper. He was used to remarks of another color. Open-mouthed he stared into Hsui's face, charmed by this sudden acceptance of his own feelings about himself. In a daze he watched Hsui take down the watch and then beckon him to a dark corner of the shop. Right there, Young Fu was given one of the greatest shocks of his life. Held in the darkness, the watch glowed into a live thing, and the figures upon its face turned before his eyes into so many tiny snakes of fire. He felt cold all over, but now that another thought of him so highly, he concealed his trembling and mumbled only, "Shi chi deh hun (extremely queer)!"

Hsui, fully aware of his victim's state of mind, pursued the game. "And only you, of all the people in Chungking, knew what to expect of this gift for an emperor. You must, indeed, be a much traveled man and a learned one, for truly this is the first time that anything of the sort has been shown in this city."

Young Fu was almost overcome with delight. The hypnotizing voice droned on: "Let me press this gift upon you. I can sleep without dreams if I know that it is in your possession."

"Do you mean to give me this precious gift?" asked Young Fu.

"Just that," insisted Hsui, "just that! You may take the watch with you now. I ask only one small favor: that you sign this bit of paper which my neighbor, Liu, will witness, and sometime when fortune is yours, send me the paltry sum of five dollars, as an acknowledgment of the gift."

The neighbor appeared as if by magic, and before the youth could catch his breath, he found himself on his homeward way, with the watch in his hand.

His pleasure in the newly acquired treasure soon faded. To begin with, his mother, Fu Be Be, was horrified at the debt of five dollars. "We shall have to beg on the streets, or starve!" she wailed. "I shall have no coffin for a decent burial!" At this last thought, tears took the place of

From YOUNG FU OF THE UPPER YANGTZE. by permission of the John C. Winston Company.

words. For the ruling desire of her life was to save enough from their income to purchase her coffin. She had dreamed of its presence in this wretched room of Dai's, a sweet-smelling wooden box to be used as table and chest until the day when she herself would occupy it in state. Now all of her hopes lay about her. Her son earned nothing, and she very little. A debt of five dollars was something not to be faced.

Defenseless against his mother's tears, Young Fu blew out the candle-light suddenly and showed her the watch in the dark. Fu Be Be shrieked. "It is some foreign devil's spirit come to live with us and disgrace my old age! What have I done that I should have a son so stupid?"

In the period that followed, Young Fu returned each evening to face these same questions and others of like nature. He went forth each morning to be accosted by Hsui or his clerk concerning the little matter of the five dollars and the "bit of paper." Under the combined torments he grew thin. And then, as if he were not already miserable enough, the watch lost its power to charm. Originally it had cost somewhere in America the sum of ninety-eight cents; it had come a long way from home and was tired. One morning in the second month of his possession, its mainspring gasped in a final effort and all of its contents settled into peaceful relaxation. A few days later, unable to adapt themselves to Chungking's uncertain climate, the small fiery snakes grew paler and paler until darkness and light became one and the same thing.

"No good! It was worn out when I got it," growled Young Fu to himself disgustedly. But for the first time in weeks Fu Be Be smiled. Within her was the assurance that the incense and rice which she had placed before Kwan-Yin's shrine had achieved the foreign spirit's death.

With her assistance two dollars had been paid to Hsui, but now the New Year was upon them and the balance was still owing. Fu Be Be refused to let him have anything from her small store of savings for this festival; better to owe a debt to man than to cheat the gods of their offerings. "That would only mean more trouble for the coming year," she said.

"But Hsui—" stammered her son, "Hsui must be paid. One day only remains before the New Year dawns, when debts as well as clothing and food must be new. He will not stop until he finds me, and then—"

Frantic with worry, Fu Be Be interrupted relentlessly, "That is your affair. You bought the watch—now it is for you to manage your creditor."

Miserably Young Fu went about the following day's tasks. In the afternoon, having found no possible solution to his problem of settling the debt, he decided that he might at least escape from Chungking and Old Hsui's search until the New Year had passed. Tang, with true holiday spirit, gave all permission to leave early, and Young Fu wasted no time in putting his own plan into action.

On several occasions his mother had mentioned a nephew, the son of her oldest brother, who was said to live in the hills across the Yangtze. Her brother was no longer on this earth, but his wife, she believed, still lived. Some day she hoped to go see for herself. It would be good to walk in the country once more and better still to renew bonds with members of her family. And now it was he, not his mother, Young Fu told himself with a rueful smile, who would first meet these cousins—and under what circumstances!

At the river's edge he asked a boatman for the privilege of helping to load vegetables and thereby earned a free ride across to the other bank. There he nodded his thanks, then walked slowly up the path to the first village on the hill. His blue cotton jacket and trousers flapped in the sharp wind, and misty fragments of the leaden sky stretched out damp, cold fingers and clung to him, satisfied with having found a permanent resting place.

The road winding past was busy with traffic. Ornate sedan chairs, hung with heavy satin and gay tassels, pushed by on the shoulders of chair-bearers in livery. Here and there a small, open, reed basket held a traveler who had made the arduous trip over the mountains, and threading in and out were hired street chairs, cracked and scarred.

Young Fu watched the unceasing stream make its bustling way down to the river bank, there to be ferried across the Yangtze to Chungking. No man in all China but would make the journey home at this season, regardless of weather or any other circumstance that might be against him. The one essential was money and a clear record. And that was just what Young Fu did not possess.

But thinking over lost delights would not gain him a night's shelter now, Young Fu said to himself. At a teashop he inquired the

location of the cousin's farm. The name was recognized and directions given. As he climbed the winding paths between the terraced fields, the cold became more intense and it was a relief to find himself at last descending into the little valley where the farm lay.

The house, solidly black against the night's shadows, was folded in quietness. Young Fu rapped sharply and someone called out, "Who is there?"

"It is Fu Yuin-fah, the son of your father's younger sister, from Chungking."

"What proof have I that you are he?"

Young Fu recalled scraps of family history, gleaned from Fu Be Be's conversations, and repeated them. After a drawing of bolts, the door was opened a crack, and a small paper lantern flickered over the outsider. Satisfied about the harmlessness of this slender boy, the farmer invited him in, asking as he secured the door, "Why are you here at this hour?"

Young Fu explained over the tea and sweetened eggs, hastily prepared for him by his cousin's wife. The family stood about him shivering sleepily while he confessed that he owed a debt and was hiding overnight from his creditor. There was much shaking of heads over such an affair, and the farmer counseled against the evil of buying that which one could not afford. In a corner the grandmother, wrapped snugly in her pu gai, mumbled her sympathy for the poor mother on whom he had brought disgrace. Young Fu became more wretched with each remark; but at last he was given a comfortable place to sleep and the house settled into silence once more.

It was still dark next morning when the others began to move about. The visitor stretched, then was startled from his drowsiness by a hubbub at the door.

"Come quickly!" called the farmer.

Young Fu unrolled his comfort and went to join the others. Outside there was a strange whiteness in the air and small pieces of soft down fluttered about their heads and settled on their garments.

"Feathers!" exclaimed the youth.

"No, snow!" contradicted his host.

Young Fu and the children of the household looked about them in amazement. "So this is truly snow, is it?" he asked the farmer again. "I have never seen any."

"I, myself, have seen it only twice—once when I was a boy and again this morning. It is very strange."

They entered the house again. Young Fu had caught up a handful of powdery flakes from the ground, and now he showed them to the wife and grandmother. The old woman rested her two, tiny, bound feet on a hot brazier. She touched a finger to the snow in his hand.

"In my youth," she said, "they would have called this a good omen for the New Year; it is the breath of the Dragon."

"Ai-ya!" exclaimed Young Fu, "it is gone!" He looked with dismay at his wet hand.

The old grandmother chuckled. "With the coming of spring heat, winter dies; so with this. Your hand was warm."

Young Fu walked to the door, and stepping outside again looked at the country about him, mistily outlined in the dawn. Hills, fields, trees, even the twisting paths lay bewitched under the spell of this white magic.

Beautiful like white jade, he thought; soft, like silk in a cocoon. "Dragon's Breath!" He gazed about him with renewed interest. "Dragon's Breath!"

Reentering the house, he asked the farmer, "Have you two large mei-shiang-tz to lend me?"

"Perhaps," was the reply. "What for?"

"I wish to fill them with snow to take to Chungking."

"Why trouble to carry snow all of the way to Chungking?"

"Lao Po Po (Grandmother) calls it the breath of the Dragon, and says it brings good fortune; once there I shall sell it to pay my debt," answered Young Fu.

After a heaping bowl of food and another of hot water, the baskets were forthcoming. Young Fu thanked them gratefully and, wishing them prosperity in the New Year, he started out.

Hurrying on his way, he halted only when he noticed that the snow was becoming less thickly spread. Here he filled his baskets, packing the cold, white substance into a compact mass. He did not stop again until the bank of the river had been reached. It was just as he had hoped—down here there was no sign of the snowfall, and certainly there would be none in the city. He glanced along the shore for a boat. His fear had been that he might have to wait too long; there was not likely to be much traffic on the river today, for no one, unless he were forced to it, would work—boatmen included. A hundred yards to the left a boat seemed to be pushing off. Young Fu ran toward it.

The boatman looked up from his load of oranges. "Ten coppers for a ride today," he called out.

"I can give you something better than coppers," gasped the youth, and swung himself aboard.

Breathing more easily after a moment or two, he reached within a basket and shaped a lump of its contents into a ball. This he held before the man's eyes.

"What is it?" came the question.

"Dragon's Breath from the hills," replied Young Fu. "It means fortune for the New Year."

"So!" remarked the boatman, very much impressed, and laid it on the floor.

In a short time they reached the Chungking side of the river. Young Fu lifted his carrying pole and climbed the steep steps to a city gate. Once within, he swung ahead to a busy thoroughfare, far from the haunts of Hsui, or those of his own friends. He located a niche in a corner of a stone wall and settled himself for business.

Nine o'clock had come, and Chungking had risen early in honor of the New Year. Within the homes there had been the ceremony of the kitchen god's return, followed by an elaborate breakfast. Now, robed in new finery, her people were about to start the day's round of excitement. Gaiety was in the air. Bunting, multicolored, floated in the narrow streets above the people's heads; from dingy house-fronts fluttered handsome banners, bright with gold characters, expressing the season's best wishes. Lace-paper ornaments, and pictures of Kwan-Yin, Goddess of Mercy, Kwan-Tih, God of Protection, and other important members of the heavenly circle shared places of honor. Fantastic lanterns and toys of every description were being offered for sale. New Year was here.

Crowds, chattering noisily, began to fill the streets. Young Fu, crying his ware with the full strength of his lungs, soon attracted their attention. Immediately the throng pressed about him.

"What is it? What is its use?" they asked.

"It is Winter Dragon's Breath come down from the hills. Hold but a little in your hand and good fortune will follow through the year! Five coppers for a touch of it—only five coppers for 'fortune's smile!' "

Fingers reached out. "Give it to the little Hsien-Seng! Here, Small Tamer of Tigers, take it in thy hand! It burns thee? Yes, but for a moment; it is the breath of the Dragon."

"Wee Sister, do not fear! It is good; it will shield thee from harm."

Trade was thriving, and Young Fu's hands ached with cold. Coppers had been pouring into the little moneybag, and he welcomed a moment of respite as the laughing people moved away. He folded his hands within opposite sleeves in an endeavor to warm them before he called to another group which was approaching. For an hour he stood there, alternately selling snow and thawing his frozen fingers, and at last there was nothing left in each mei-shiang-tz but tiny pools of water.

Young Fu shouldered his empty baskets and walked toward his own section of the city. A li from Hsui's shop, he sat down on a doorstep and lifted the coin bag from his belt. He counted carefully—three dollars, and forty coppers over! Back into the bag he thrust the change, and made directly for Hsui's shop.

The store was boarded up for the holiday, but a series of knocks soon brought the proprietor himself to the entrance. In his hand he swung a lighted lantern. Sliding back the panel to its full width, he stared at Young Fu in amazement. "What do you want and where have you been hiding?"

The boy grimaced at the sight of the lantern. Hsui, along with other business men, would through the hours of to-day's sunlight carry a lantern, thereby announcing to his debtors that for them the New Year had not yet dawned. The name, Fu, at least, was no longer among these unfortunates. Suddenly he looked Hsui full in the face. "I wish to pay my debt; as for where I have been, that is my affair." He pushed the money toward the other. "Give me the little paper!" he demanded.

The transaction completed to his satisfaction, he stepped into the street again. For the first time in weeks, he breathed freely. His account with Hsui was closed, he was back in Chungking with the day still young, and in his moneybag were forty coppers. Truly, the breath of the Dragon had meant good fortune to him.

"Open the door!" he shouted when he arrived at Dai's.

Fu Be Be lifted the latch, then watched him enter with fear in her eyes. "Did he find you?" she asked.

"That is an affair of the past," replied her son. "I was able to discover a way out and the matter is settled."

"When did you acquire so much ability, Honorable One?"

Young Fu smiled knowingly, then explained. His mother was speechless. Reaching into his belt, he drew out the forty coppers. "Here is a New Year's present toward your coffin," and he placed them in her palms. Her eyes softened.

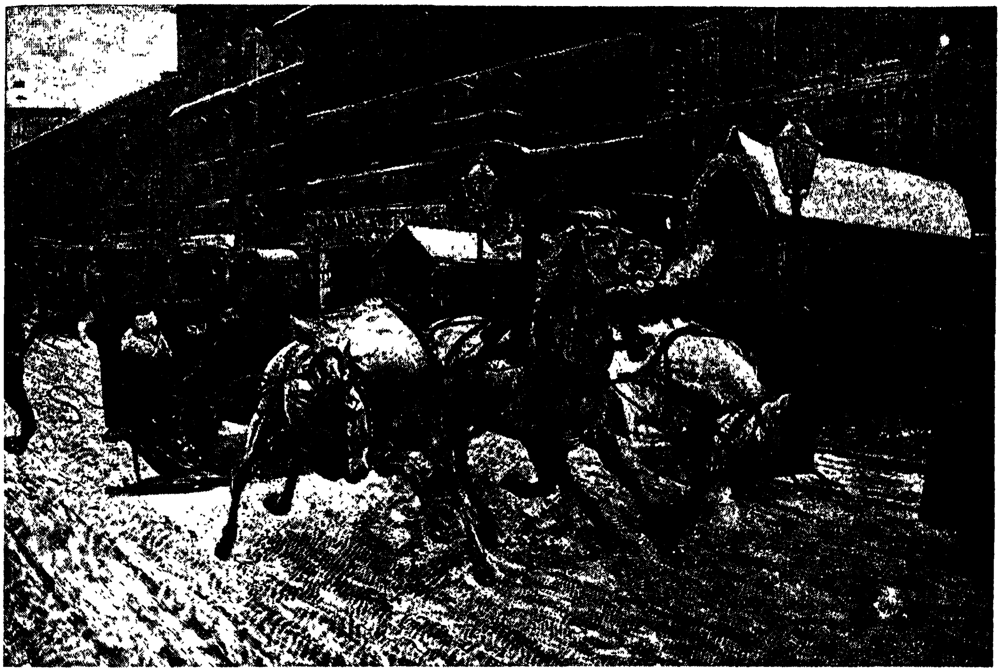
"Tell me," he insisted as he stretched across the table for some fruit, "am I still the most stupid member our family has produced?"

THE NEXT STORIES ARE ON PAGE 5755.

THE RUSSIANS ACCEPT CHRISTIANITY

Culver Service

Russia became Christian in the tenth century. Here people are wading into a river to be baptized.



Culver Service

A spirited scene from the old days. A Russian troika (three-horse sleigh) is driven over snowy city streets.

RUSSIA *and* HER STORY

OVER a thousand years ago, when legend was merging into history, we first hear of Russia. It was a land of mixed tribes, badly governed, and very much in need of law and order. In those days the roving Northmen were renowned throughout the world for their bravery. According to one story the Russian tribes living around Novgorod sent this message to the Northmen: "Our land is great and bountiful, but there is no order in it. Come and rule over us." Three bold Viking brothers responded to the invitation, and crossed over from Scandinavia. Rurik, the chief of the brothers, founded a line of kings, and for centuries Russian rulers claimed to be descended from him. Some people do not believe this story. They think that Rurik became ruler by conquest and not by the wish of his subjects.

In the reign of Vladimir, the Russians were converted to Christianity (988). Vladimir chose to belong to the Eastern, or Greek, Church, and Russia became a bulwark of this church, which is sometimes known today as the Greek Orthodox Church.

In the centuries that followed the coming of Rurik there was almost continual civil war in Russia. The country was divided into rival principalities, and the more powerful among them, Novgorod, Kiev and, later, Moscow, struggled for leadership. This strife within the country was partly, but not entirely, checked by danger from the outside. In 1222 hordes of Mongols, or Tartars, nomads from the deserts and steppes of Asia, descended on the country, and for more than two hundred years Russia was obliged to recognize them as conquerors and to pay heavy taxes. From time to time there would be new invasions. Moscow was taken and burned by the Tartars more than once.

As time went on, the Russians gradually regained their independence. Ivan III, or the Great, who reigned as Duke of Muscovy in the latter part of the fifteenth century, refused to do homage to the Tartar ruler. Ivan founded the modern Russian state. He rebuilt Moscow. By this time the double-headed black eagle had been adopted as the arms of Russia.

Ivan IV was called Ivan the Terrible, because he was so insanely cruel; but he was also a man of great power. Born in 1530, he became king at the age of three years; and in 1547 he took the title of Tsar of All Russia. He annexed many cities and states on the great Russian plain. At last his dominions reached Astrakhan on the Caspian Sea, and stretched north as far as the White Sea and the vast northern Asiatic regions, formerly known as Siberia, and now known as the Asiatic part of the Union of Soviet Socialist Republics. He began trade with England through Archangel; and he hoped to force a way to the Baltic Sea, but Poland and Sweden blocked his path westward. Ivan used the Cossacks to defend the eastern frontier of his realm. The Cossacks were bands of mounted soldiers, brave and fiercely independent. It was a Cossack leader who conquered a large part of Siberia for Ivan. In central Russia, Ivan stamped out every sign of opposition with relentless cruelty.

After Ivan died, in 1584, disorder followed. One consequence of his wars was that the peasants had been reduced to a state of serfdom, which lasted for three hundred years. The laborers became so few in numbers that the landowners competed for their services, and they were strictly forbidden to leave the estate on which they had been born. They had rights of tillage in the common land of the place, but they had to give their services for the cultivation of the estate of the landed owners, and they could not go elsewhere.

Michael Romanoff's dynasty ruled from 1613 to 1917.

Ivan the Great rebuilt Moscow, burned by Tartars.

Thirty years of confusion and war followed the death of Ivan the Terrible. During this period the Poles occupied Moscow and the Swedes held Novgorod. At last the Russians rose in despair. They drove out the invaders, and called together a National Assembly. The Assembly elected as tsar, or emperor, Michael Romanoff, the first sovereign of a new line. This event took place in 1613. The Romanoffs, chosen by the common consent of the people, continued to reign till 1917, when Tsar Nicholas II was forced to abdicate.

The most famous sovereign of the Romanoff family was Peter the Great, who mounted the throne when he was seventeen, and reigned from 1689 to 1725. Peter was determined to have his own way, and, fortunately for his country, he was a wise and able ruler.

Even as a boy he realized how backward his country was. He went abroad to Holland and England, and later to other countries, and he worked in the shipyards in order to obtain first-hand knowledge of shipbuilding. Then he returned to Russia and,

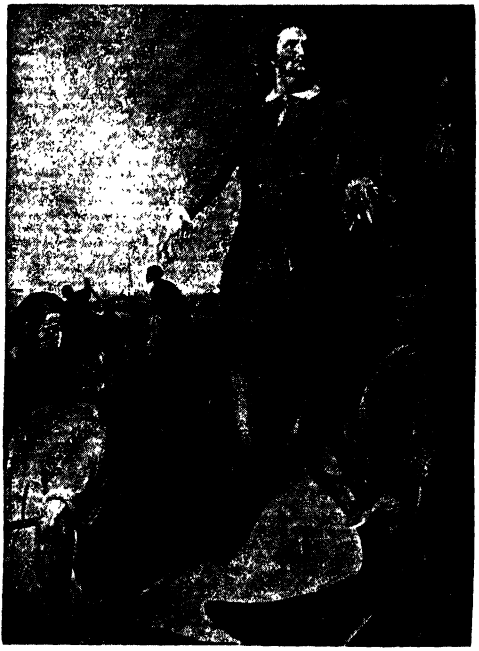
Peter the Great, who was to bring European ideas to Russia, is saved by his mother from an assassin. Peter built St. Petersburg and named it for his patron saint. This city is now called Leningrad.

to the disgust of many of his people, he began to introduce some of the improvements he had seen in other lands.

Living a remote life far from other countries, and surrounded by peoples as simple and rough as themselves, the Russians naturally clung to their old customs. But Peter determined to make them change. It was a national habit to grow a beard, and many simple-minded people thought it wrong to cut the beard or hair. But Peter made his chief officials shave, as part of his plan for breaking up the national habits and giving fresh ideas a chance. He began by cutting off the beards of his principal officers himself. Afterward a tax was put on beards.

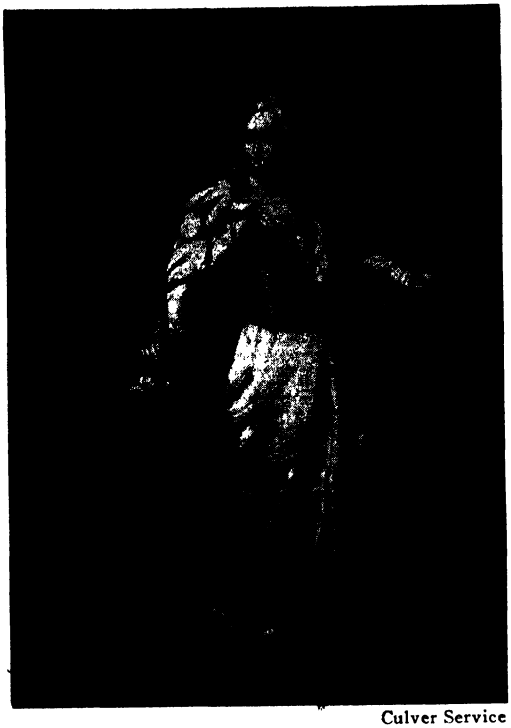
It must not be supposed that Peter himself was much more civilized than his people. He was coarse, boisterous, and as tyrannical in spirit as most of the earlier Russian rulers had been. But he saw that Russia must adopt the ways of civilized nations if she was to take her place among the leading countries.

He tried to bring knowledge to the country through libraries and museums. He brought in foreigners to train Russian rulers. He extended the means



Culver Service

Peter the Great founding St. Petersburg.



Culver Service

Catherine the Great was a strong and wise ruler.

Culver Service

Russian peasants drinking tea made in a samovar.

of travel and of trade by making canals. He also gave Russia the beginnings of a navy, first on the White Sea and then on the Sea of Azov. His next dream of conquest was to make himself emperor of the east, but Turkey blocked the way.

PETER GAINS A BALTIC OUTLET AT SWEDEN'S EXPENSE

Peter found a worthy foe in Charles XII of Sweden, one of the greatest military leaders of all time. After the death of Charles, the Russian monarch forced Sweden from the eastern shores of the Baltic and made that sea the chief Russian outlet to the west. He then built the city of St. Petersburg (afterward named Petrograd, and then Leningrad) as his capital. Peter the Great found Russia a half-savage nation on the outskirts of Europe; he left it a nation that henceforward had to be reckoned with as an outstanding European power.

Peter was succeeded by his second wife, Catherine, who reigned as Catherine I, from 1725 to 1727. In the next seventy years three other women—Anna Joannovna, Elizabeth and Catherine II—ruled over Russia. Peter II reigned for three years only (1727-30).

Catherine II, a German woman, who is often called Catherine the Great, was empress for thirty-four years, from 1762 to 1796. She mounted the throne after her husband, Peter III, was murdered, and she ruled by sheer force of character and statesmanlike ability. Catherine followed the policy of Peter the Great by bringing to her court foreigners with helpful ideas. Her ambition could never be satisfied, and she made large additions to her empire, including the Crimea, taken from the Turks; the Black Sea region around Odessa; what is now the Lithuanian coast on the Baltic; and a large share of Poland.

Catherine was followed on the throne by her son, Paul. He was a weak man, who was fascinated by Napoleon and wished to join him in an attempt to divide the Turkish Empire and then conquer India. In Paul's reign another province was voluntarily given by its prince to Russia. This was the ancient kingdom of Georgia, beyond the Caucasus Mountains. In 1801 Emperor Paul was assassinated, and his son, Alexander I, became tsar.

At first Alexander was inclined to act with Napoleon, if he could have his full share of influence throughout Europe. But presently he recognized that there was no room in

Culver Service

The Kremlin was the ancient palace of the Tsars, and the first place of Christian worship in Moscow. It is today a vast collection of government offices and other public buildings.

Europe for two such monarchs. Then Russia, next to England, became Napoleon's most persistent enemy.

In 1812 Napoleon determined to crush his Russian foe. He invaded the country in June with a huge army, and at first he won many successes. He entered Moscow in September, 1812, and waited for the Tsar to surrender. But he waited in vain. The Russians burned the city, so that it would not give shelter to Napoleon and his men. At last, with the terrible Russian winter setting in, the French dictator had to retreat. This retreat was one of the most disastrous in the history of warfare. Only a small part of the army of invasion managed to escape the frightful cold and the swarms of Russian troops, and get back to France.

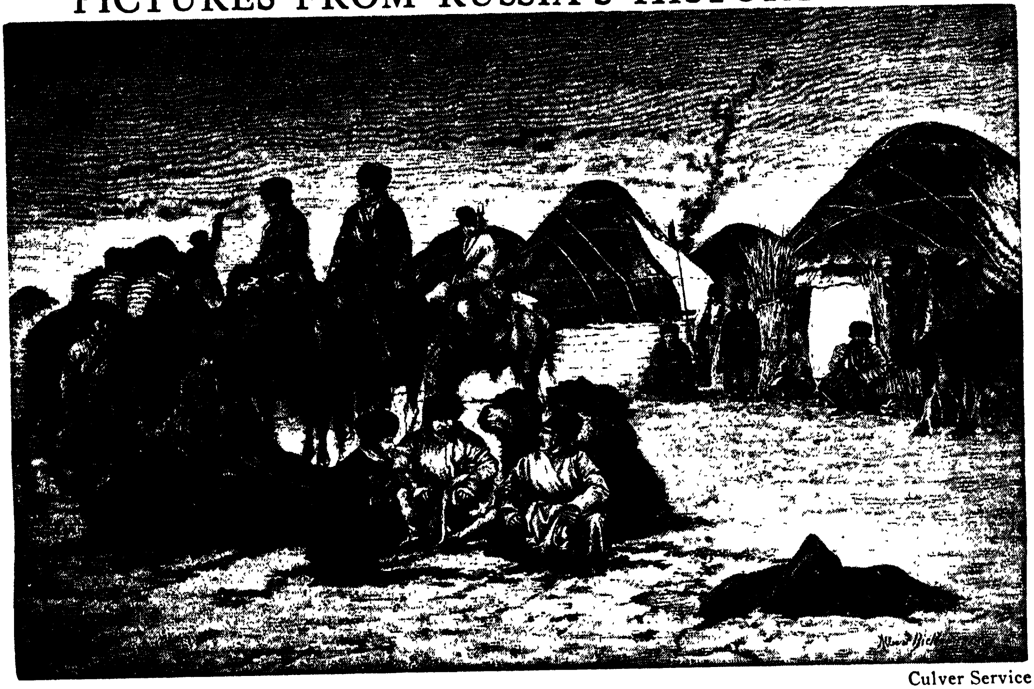
Russia took an important part in the fighting that followed the return of Napoleon to France. At last, in April, 1814, Napoleon was forced to abdicate. He returned to power for a short time in 1815. But he was utterly defeated at the Battle of Waterloo in June, 1815, and he ended his days as a prisoner of the British on the small island of St. Helena, in the South Atlantic.

Early in his reign Alexander had favored improved education, a just government, possibly on constitutional lines, and the overthrow of the serf system. But when the armies of the European monarchies had crushed Napoleon and placed France again under the tyranny of the Bourbon family, he went back to the view that all nations, including Russia, would be happiest under the governments of absolute rulers.

Russia, however, had now come into the family of European nations, and many of her younger men knew the difference between Russian tyranny and the political freedom that men enjoyed in a country like Great Britain. The Russian liberals joined secret societies, and plotted to bring about changes which could not be sought openly. This underground movement troubled Russia for the next hundred years.

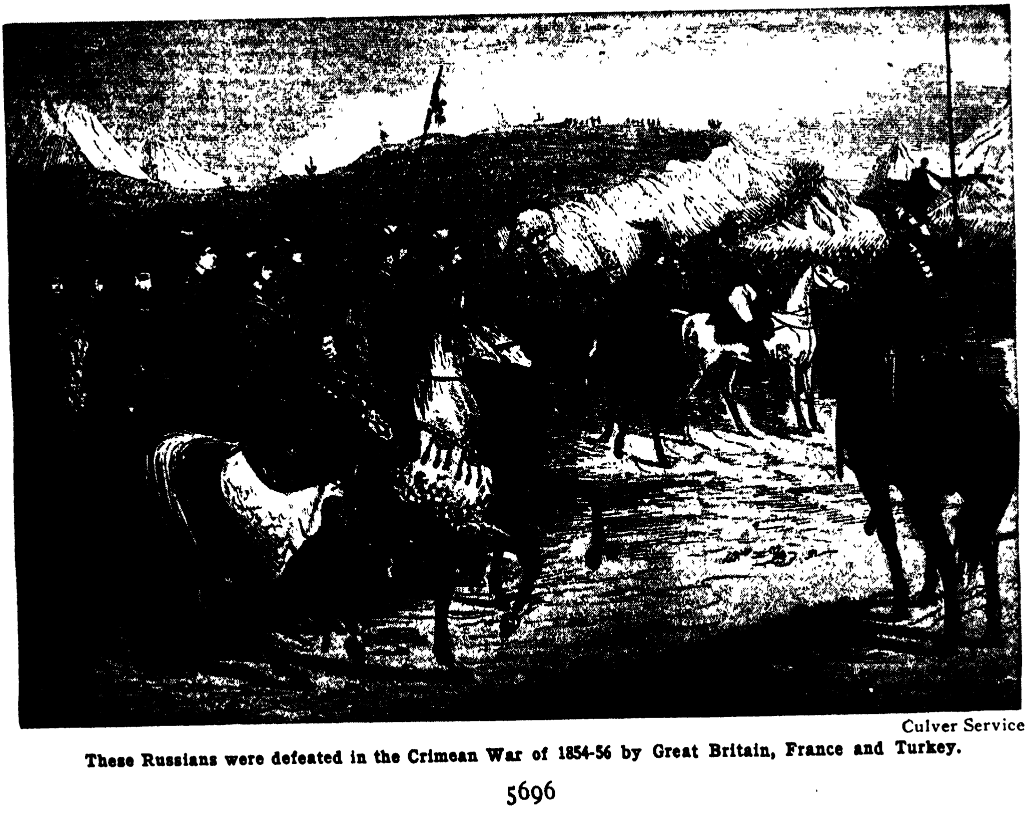
Alexander was succeeded in 1825 by Nicholas I, his younger brother, a hard man who loathed the idea of political liberty. For thirty years he sternly discouraged all expressions of public opinion about the way in which the Russian people was governed. He also disliked liberal movements in other countries, and helped the emperor of Austria to crush a revolt among his Hungarian subjects. Nicholas was a firm foe of the Turks. He succeeded in winning self-govern-

PICTURES FROM RUSSIA'S HISTORY BOOK



Culver Service

In Russia, level plains are called steppes. Here is an old-time scene on the steppes of Kirghiz.



Culver Service

These Russians were defeated in the Crimean War of 1854-56 by Great Britain, France and Turkey.

Alexander II, liberator of the serfs.

ment for Wallachia and Moldavia, formely Turkish provinces; he supported the Greeks in their fight for independence against the Turks. The Tsar carried his opposition to Turkey so far that finally Great Britain and France supported the Turks against him in the Crimean War (1854-56). The Russians were beaten in this bloody struggle.

Alexander II (reigned 1855-81), the successor of Nicholas I, tried to reform Russia and to give her the institutions of a free country. In 1861 a decree was issued freeing within two years all the Russian serfs, who numbered 23,000,000. Steps were also taken to establish local government, and trial by jury was established. Attempts were made to develop the industries of the country. Tsar Alexander II was the popular national hero. There was great hope that a new era had dawned for Russia.

But disappointment followed. Prosperity did not come as swiftly as was expected. More reforms were asked for hastily, and were not granted. Secret societies again became active, and were repressed. Then murders of officials became common. Spying and counterspying spread everywhere. Finally Alexander II, who had been hailed twenty years before as the savior of his country, was murdered in 1881 by a bomb thrown under his carriage as he rode through the streets of St. Petersburg.

During Alexander's reign, by the help of the Russian army, Bulgaria obtained freedom from the Turks, but the Russians were prevented from entering Constantinople by the threats of Great Britain and Austria. The British at that time were very suspicious of Russia's conquests in central Asia.

Alexander III, the son and successor of Alexander II, had no sympathy with what his father had done. He thought that the extension of greater liberty to the Russian people had been a failure, and he returned to the stern methods of government of the earlier tsars. He had great faith in his secret police, which became an important agency of the government. Those who

Culver Service

The coronation procession of Alexander III. This stern monarch undid his father's liberal reforms.

opposed the Tsar were sent to imprisonment in Siberia by tens of thousands. This third Alexander's interference with his people extended to all their interests in life. Russians who believed in other religions than that of the Orthodox Church were persecuted. Minority groups were not allowed to use their own languages. So discontent spread throughout the land, and secret societies favoring revolution increased. Tsardom became hated.

This was the state of things when Alexander III died, and the last of the Romanoff rulers, Nicholas II, became Russian tsar in 1894. This weak man followed in the steps of his father. His advisers urged him to be strong and stern, and his wife, who had great influence over him, sided with them. The revolutionary societies that used murder as a weapon became stronger than ever.

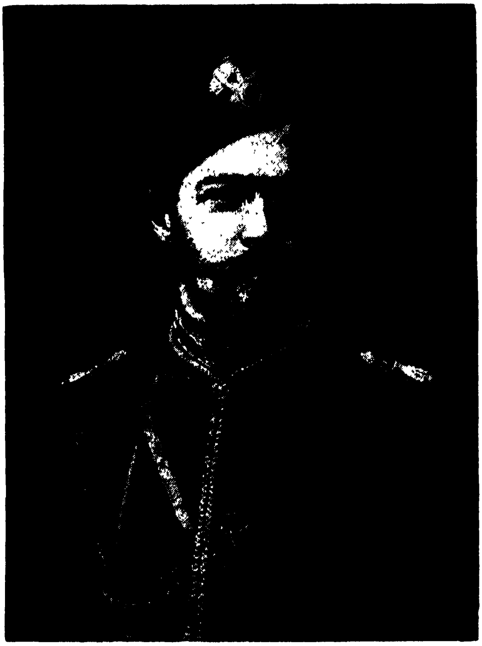
Meanwhile, Russia had sent armies to the Pacific coast across Siberia and had erected a great fortress there at Port Arthur. The immense Chinese province of Manchuria, joined with European Russia by the Trans-Siberian Railway, had fallen under Russian influence. It seemed likely that this influence might also be extended to Korea.

The Japanese, who had designs on Korea themselves, were alarmed. They saw a giant power coming nearer and nearer, with what looked like irresistible force. In February, 1904, they flung themselves on the outpost of the great Russian Empire. The result of this military action astonished the entire world. On land and sea the Japanese were everywhere victorious. The Russian fleet was utterly destroyed. The great fortress of Port Arthur was besieged and taken. The Russian armies were flung back in great and terrible battles. When the Treaty of Portsmouth ended the war, in September, 1905, Russia was a thoroughly defeated nation.

Grand Duke Alexis, son of Nicholas II and heir to the imperial throne.

During the unsuccessful war against Japan (1905), the long-smoldering unrest at home flamed into open rebellion. There were serious riots and strikes all over Russia. The Tsar found himself at last compelled to promise representative government, and the first parliament, or Duma, met in April of the next year. The hopes of the Russian people, however, were soon shattered. The decisions of the Duma were ignored and the old rule of injustice and oppression continued. A few weeks before the outbreak of World War I, things had again become so bad that Russia stood on the brink of revolution and there was fighting in the streets of Moscow.

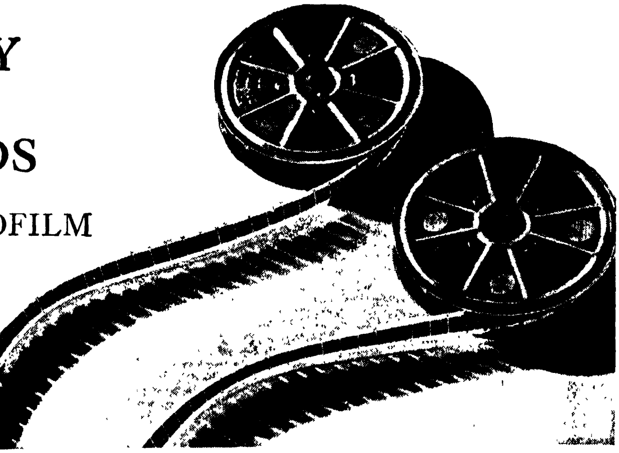
The first years of World War I, about which we tell you in another chapter, united the nation again for the time being. But in March, 1917, after countless Russian soldiers had been needlessly slaughtered because of the inefficiency and corruption of the government, the people rebelled against the Tsar. He was forced to abdicate and the entire old order was swept away. The entire imperial family, including Nicholas II, were put to death. A new Russia was to rise from the ashes of the old.


Nicholas II ruled Russia badly until 1917.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 5847.

A NEW WAY TO KEEP OLD RECORDS

THE STORY OF MICROFILM



Pictures in this article, except on page 5703, Recordak Corporation

WHAT does the use of paper mean to the world we live in? We can not think of any way in which the wisdom and history of the world could have been kept for us if the men of old had not learned how to set down accurately their thoughts and the facts which they knew about the world they lived in. For a long time this knowledge has been set down on paper. And we continue to write and to print on paper the laws and records we need to keep; the messages we send; and the newspapers and magazines and books we read and study every day.

Now, you know that many of these documents are very important; and paper is a rather fragile substance. Even the best paper, which is made of linen rags, tears easily and burns easily. If it is handled a great deal, paper wears out and falls to pieces; and valuable records may be lost in this way. You can imagine what a lot of trouble it would cause if the important papers kept at the bank were destroyed; or precious books kept at the libraries were burned; or if the legal documents filed at the court house were lost or so worn that they could not be read properly. And we have to remember that an accumulation of books and letters takes up a great deal of room which is often needed for other purposes.

It was thousands of years ago that people began to use words or signs to set down what they wanted to remember accurately or to communicate to others. Almost as soon as they began doing so, a new problem arose, the problem of copying what was set down in order that, if the original were lost, there would be a copy to refer to. Until the end of the Middle Ages this copying was done by hand (except in China where it is said movable wooden blocks were used to print official proclamations). Patient monks spent their lives copying precious manuscripts. Their copies were beautiful affairs, often decorated with pictures and fine lettering done in colors of gold and silver.

But that was a very slow way to copy, and only a few people could afford to purchase these precious manuscripts. Men tried to think of some way to copy more quickly and cheaply, and in the fifteenth century (1436-1440) Johannes Gutenberg, a German printer, invented the first printing press for movable type. Ever since that time men have continued to improve the printing press until to-day it furnishes us, often very cheaply, millions of books and newspapers and magazines. Since it costs a great deal to set up the type for this kind of printing, it is only when many copies of the original are required that this method is practicable.

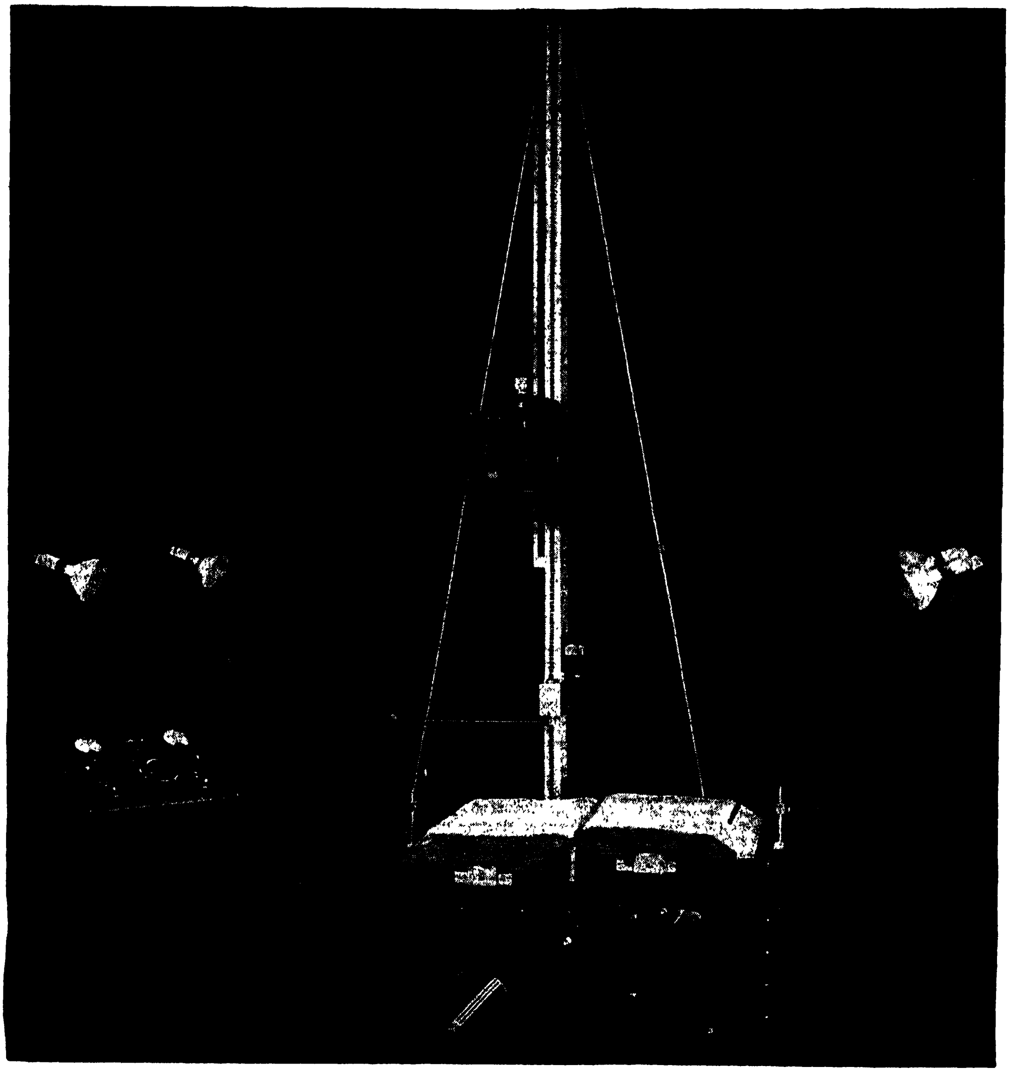
In the nineteenth century someone thought of the duplicating method which we call mimeographing, and this is useful and not too expensive when a few hundred or even a thousand copies of a letter or tracing are needed. We also have a system of copying called multigraphing. A multigraph is a sort of very simple printing press, and is used in many offices.

All these ways of duplicating depend upon the person who does the copying, and you know that, however careful one may be, a person can not copy as accurately as a camera lens. Even the patient, careful monks made mistakes in the precious manuscripts; and many a comical mistake occurs in a printed book when the typesetter uses just one wrong letter.

So when cameras became common, someone thought of photographing important documents. It is called the photostatic method. This is perfectly accurate and is used for copies of birth certificates, etc., which may be the exact size of the original, or larger, or smaller.

We still use all these ways of copying and, of course, we have the typewriter as well. But the files of business offices and libraries and banks and government bureaus were becoming more and more crowded and cluttered with records and papers and documents that, in some instances, had been accumulating for hundreds of years. People began to say that the world might be buried under an avalanche of paper if something were not done about it.

Around 1930 a new method of duplication, or copying, called microfilming or microphotography, was invented. By this method pages of books and magazines and letters and maps can be copied so that they may be safely kept in a very small space.



This photograph shows how a rare old book is microfilmed, page by page, to preserve the contents when the book has crumbled. The turning of the pages and the focusing of the camera are done automatically.

Even the big dictionary itself can be copied on a strip of microfilm and put in a metal container that you could carry in your pocket. Micro (pronounced mike-row) means very small. The president of the famous Rockefeller Foundation in New York, Raymond D. Fosdick, has called this process perhaps the most important advance in duplicating the printed or written word since Johannes Gutenberg began printing with movable type. The process is particularly well known to us to-day because of the V-mail letters sent to and received from our men in the armed forces overseas.

Exactly what is microfilming? It is the copying of book pages, drawings, maps, records, letters and other papers upon a narrow ribbon of film made of cellulose acetate. This is called microfilm; it comes in two widths, one about 1⅜ inches (35 millimeters) wide; and the other about ¾ of an inch (16 millimeters) wide. The wider film is in 100-foot lengths, and the narrower film is 200 feet long.

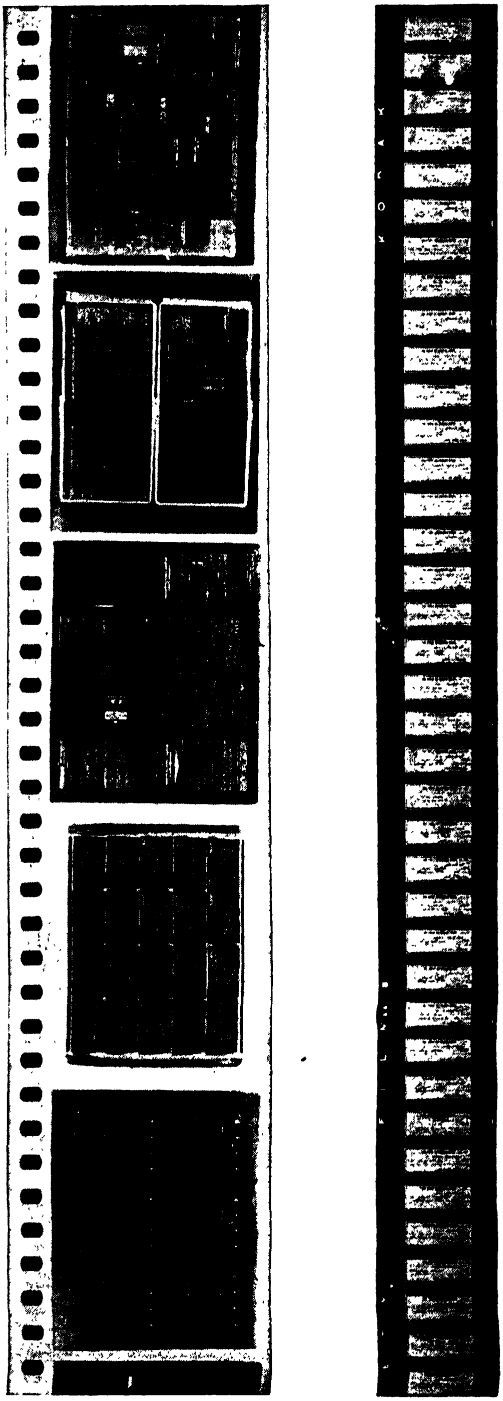
THE CHIEF STEPS IN THE MICROFILMING PROCESS

These films are wound on reels and put in the camera which is to take the pictures. Then the sheet to be photographed is brought into focus in front of the camera. As the reel of film unwinds, a small section of it is brought into position in the camera, an exposure is made and that part of the film passes on and is wound on a spool. As one page after another of the material to be duplicated is brought into position before the camera lens, an exposure is made, that is, a picture is taken.

When all the film has been exposed, the spool is taken from the camera, and the film developed, and we can see the series of tiny images on the film, separated from each other by a border as shown on this page. The pictures are very much smaller than the original from which they are taken, and a page ten inches square may be reduced to less than a square inch.

You will notice that these tiny images are like the negatives from which photographs are printed. What is dark in the original is light in this negative microfilm, and what is light in the original is dark in the film. Prints are made from these microfilms as from any developed camera film, and the finished pictures show light and dark as they were on the subject which was photographed.

The microfilm pictures are much too small



Samples of microfilms — pages from account books, printed matter, sketches. At the right, checks.

How microfilms are read. The film is inserted at the top; the image is greatly enlarged, as you see.

to be read by the naked eye, so when anyone wishes to read the films they are placed in a reading machine like those shown on this page. As you see above, an image of the same size, or perhaps larger than the original, is thrown upon a screen. If reading machines are not available, the microfilm may be read with magnifying glasses made particularly for this purpose.

From microfilm, full-size copies of originals may be printed on cloth, cellulose acetate or paper, and these reproductions bring out each detail of the original with perfect accuracy, the duplicates costing no more than photograph prints.

You will remember that one of the very important reasons for using microfilm is to protect copies of valuable papers and documents from destruction by fire. For that purpose the developed films are usually wound on reels and enclosed in round metal boxes about three inches in diameter. If a number of short, unconnected subjects have been microfilmed on the same strip of film, it may be cut into short lengths. These are left flat and placed in long thin envelopes that are stored in carefully labeled boxes. Sometimes cut film is placed in cloth pockets sewn on the backs of filing cards, which are placed in ordinary filing cabinets.

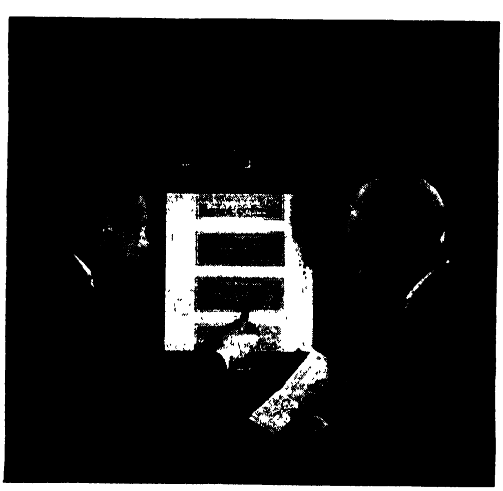
Another very important value of microfilming is that the cellulose acetate of which the film is made is very durable, is nonexplosive and burns very slowly. The Bureau of Standards at Washington tells us that microfilm made of cellulose acetate will last at least 500 years, and probably much longer.

The widest use of microfilm up to the present time has been among business and industrial companies, banks, insurance companies, advertising firms, designers, lawyers and other groups that need to keep their valuable records, stock ledgers, correspondence, legal documents, drawings and other papers safe.

Microfilming has been used by many government and city bureaus in both the United States and Canada. The United States Government, for example, stores the records of the United States Census, Selective Service and Social Security in a very small space by using microfilm. Old records have been recorded on microfilm and then the bulky records have been destroyed, thus releasing space for other purposes. Microfilm records are accepted as evidence in a court of law.

In a number of libraries microfilm is replacing bound volumes of old newspapers that crowded the shelves. The most important project of this sort has been the microfilming of the entire back file (with the exception of a few missing issues) of the London Times, going back to the year 1785. In the more than 8,500 feet of film on which the Times has been reproduced, one can find a remarkably complete history of events covering a stirring period.

Nearly every library has some rare books



Checks on the reading screen. Census cards and many other government records are microfilmed.

and manuscripts and other books that are too badly worn to be used by the general public. Formerly these could be read by only a few people who had special permission to do so. Much of this material has now been reproduced in microfilm and thus made available to all readers.

Learned men and students have found microphotography very useful. Formerly those who wished to consult rare books or manuscripts often had to travel long distances to the libraries where they were kept, or had to have them copied by hand at great expense. Now a number of libraries are prepared to supply microfilm reproductions of any item on their shelves or on the shelves of nearby libraries. The cost of this service is only a cent or two a page. Among the libraries providing this special service are the United States Library of Congress, the Library of the United States Department of Agriculture, the Harvard University Library, the Library of the University of Chicago and the Library of Brown University.

It is hoped that microfilming will play an active part in the friendly relations between the different nations in the Western Hemisphere by making the literary and scientific treasures of all the countries of the Americas available to the citizens of all the other countries. Already, under a grant from the Rockefeller Foundation, Brown University has been recording in microfilm many of the books and papers in the libraries of South America, Central America and Mexico. The pictures are taken at the libraries and the film sent to Brown University after it is developed; there prints are made for the University Library and for the Library of Congress in Washington.

Microfilm has played an important part in World War II. Perhaps the greatest service it has rendered has been to save the contents of precious books and manuscripts which were in danger from air bombardment. The famous library of the University of Louvain, in Belgium, rebuilt after World War I with money raised by American school children, was again destroyed by the Germans in World War II. The libraries of England suffered greatly, and many books, manuscripts, maps and charts were destroyed by bombs and fire in the first two years of the war. Later many of the documents which remained unhurt were microfilmed and the films safely stored away. Grants of money from the Rockefeller Foundation helped to make this work possible.

Courtesy, New York Life Insurance Co.

The 50,000 cards in this cabinet have been microfilmed; the films are in the small boxes on top.

The English treasures photographed were chosen from the British Museum, the Public Records Office, the libraries of Oxford and Cambridge universities and other places. Copies of each microfilm are kept in Great Britain and in the Library of Congress at Washington.

We know, too, that microfilm is being used in important espionage work, although even after the end of the war we may never be told to what extent this is being done. But we do know that in 1942 the United States Federal Bureau of Investigation seized several microfilms, reproducing valuable United States defense documents, which German agents were sending to Germany by mail.

The FBI men changed these films in such a way as to make them practically worthless, and then allowed them to be sent on to their destination, because they did not want the German agents in America to know that they were under suspicion. The unsuspecting spies were later severely reprimanded by their superiors in Germany for the poor quality of the microfilms that they had sent! Afterward, all the spies involved were arrested.

And that is how microfilming is done, to save space and time and many precious treasures for us, and for the generations of people who will live after us in the world.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 5901.

THE LADY WITH THE LAMP

FLORENCE NIGHTINGALE

TO-DAY we take as a matter of course the care of trained nurses for those who are ill. It is only when we know something about the kind of care the sick and the wounded had less than one hundred years ago that we can appreciate the great changes brought about by Florence Nightingale, a brave and great-hearted Englishwoman.

She was born in 1820, in the beautiful Italian city of Florence, and she was given its name. As she grew into a merry little girl, she did not go to school but was taught at home, mostly by her father. There was a deep bond of sympathy between father and daughter.

Florence learned some Latin and Greek and several modern languages. She also read a great deal, even scientific books, and remembered and thought about what she read. There was a younger sister, and there was a host of cousins with whom the Nightingale sisters played. It was a happy, pleasant life; and Florence enjoyed the games and the parties and the visits among her cousins.

However, she said later that even as a child she had had the sense of a mission, that is, the feeling that she had been born for a particular purpose.

As Florence grew older, she became aware of suffering, even though it was far removed from her own circle. She saw misery in the village only a few miles from home, and one could not step out on the streets of London in those days without seeing the suffering of the poor.

Florence came to feel very strongly that her pleasant social life was a waste of time, so many people were in misery. Her desire to do something about it was intense, but in those days young women like Florence were supposed to remain at home. Her private papers show how her interest in nursing was growing. In 1845 she wrote, "I saw a poor woman die before my eyes this summer because there was no one but fools to sit up with her."

Florence Nightingale as a young woman.

While there were women nurses in her country, they were usually ignorant and without any training. When Florence told her family of her interest in nursing, her mother was horrified. There were evil conditions in hospitals—drunkenness was common—but it was because the conditions were so bad that Florence wanted to help improve them.

Meanwhile, she read and studied what she could of medicine and sanitation. On a trip to Italy in 1847-48, she studied the work of the Catholic orders in Rome. There she met Sidney Herbert, an Englishman who helped her greatly in later years.

Several young men wanted to marry Florence. She refused them all, even one to whom she seems to have been attached. She believed that she would be happier if she remained free to carry out her work.

In 1851 she obtained permission from her parents to spend three months at the Institution of Deaconesses at Kaiswerswerth, Germany. There was not much real training, but the spirit of the institution was good. In Paris, two years later, she was able to inspect hospitals, infirmaries and religious houses, and saw famous surgeons at work.

At last she obtained the position of superintendent of a home for poor, sick governesses. And now she saw most clearly the need for giving nurses real training. Her next plan was to open a school for nurses, but a sad, though great, experience was to come first.

The Crimean War broke out in March, 1854, and the terrible siege of Sevastopol began in September. Soon all of England was shocked by a series of newspaper articles which told about dreadful conditions in the Crimea, especially the lack of care for the wounded and sick. There were not enough surgeons and nurses. There was not even enough linen to make bandages, and in some cases the wounded had no care for a week.

Florence Nightingale at once set about getting official permission to take a band of nurses to the Crimea. Her plan was sent to Sidney Herbert, who had become Secretary of War. By a strange coincidence, he wrote to her at the same time, asking for her help; and their letters crossed in the mail.

Florence gathered a group of thirty-eight women. She had chosen them all very carefully. She knew that impulsive kindness alone would not stand the test of what the nurses would have to do and see. Ability, self-control and willingness to obey orders were more necessary qualities.

The two hospitals in which Florence had charge of nursing were at Scutari, on the Bosporus, a short distance from Constantinople. One of them was the General Hospital, which had formerly been a Turkish military hospital, where conditions were not quite so bad. The other was the overcrowded Barrack Hospital.

A LIFETIME OF SERVICE BEGINS IN THE HOSPITALS AT SCUTARI

Florence chose to stay in the Barrack Hospital. The building itself was poorly constructed, with cracks in walls and floor. Under it ran poor sewers. The men were suffering, not only from disease and wounds, but also from lack of proper food, and they were overrun by rats, mice and vermin.

Florence found "not a basin, not a towel, not a bit of soap, nor a broom." The filth was appalling. She said to one of her nurses, "The strongest will be wanted at the washtub."

And then, on November 9, the wounded began to pour in from Balaclava. Only the strongest character, man or woman, could have faced such a situation without flinching. Her duties went way beyond nursing. She found boilers in which to wash clothing, bed linen. She provided beds and other furniture and equipment, medicine and even clothing—50,000 shirts at one time. Some repairs were made to the building on her orders. The worst period lasted six months and in all that time Florence was hardly ever out of the hospital.

The greatest of Florence Nightingale's gifts was an ability to organize, to bring order out of confusion. It was done with sympathy and gentleness, but it was done!

A long step forward in her work was the rule that the nurse is under the doctor's orders and is not his rival. She also designed uniforms for the nurses. The cape is still worn.

All this time she was writing countless letters to the authorities, describing conditions and asking, in strong but tactful terms, for what was needed. She was impatient of delays and red tape, sick at heart that any soldier might die because supplies were lacking.

She had to win her point against the jealousy of doctors and the prejudice of officers. They did not like the idea that a woman should have authority. Her manner and her voice were gentle, but she could not be turned aside from her aims.

LIVING CONDITIONS FOR THE BRITISH SOLDIERS ARE IMPROVED

Time was also found to establish reading rooms and classes for the soldiers. Some people called it pampering, but she knew that to keep the men in idleness was bad for them and for the army.

All her life Florence Nightingale had a warm affection for the British soldier. She saw how he endured suffering and hardship without complaint. Often, during these months at Scutari, when a case was given up as hopeless, she would take care of the man herself.

She worked sometimes for twenty hours at a stretch. She would walk softly through the wards late at night to see that all was well. It is said that the men turned to kiss her shadow as she passed, out of deep, silent gratitude. Longfellow called her The Lady with the Lamp, but the lamp was an ordinary camp lantern.

At the end of six months the death rate in Barrack Hospital had fallen from 42 out of every 100 to 22 out of 1,000 cases.

Then, in May, 1855, Florence herself came down with fever. It seemed for a few days that she might not even live. The danger passed, but she was left weak and exhausted. Yet she would not go home! By July she was writing again, and by August was busily at work.

On September 8, 1855, Sevastopol fell. But Florence stayed on until the war was over (March, 1856) and the last shipload of soldiers had sailed. In England, everyone knew of the wonderful work she had been doing. She became almost a national heroine; yet she never appeared in public. Her work was the only important thing in her life. The experience at Scutari was only the beginning, a step toward her goal of creating a skilled nursing service and opening a worth-while profession to women.

Besides this, she was determined that soldiers should never suffer from neglect again as they had in the Crimea. And so began a period, which lasted many years, of working privately with the War Office, the government department which has charge of the army. The death rate of soldiers in England, even in peacetime, was double what it was in the civilian population. She never had an official position, but her influence became very great.

THE LONG YEARS OF TIRELESS EFFORT SLOWLY BRING RESULTS

Slowly, much too slowly for Florence Nightingale, many of her ideas were put into practice. She made plans covering such a wide range of problems as diet and cooking, sanitary arrangements and construction of hospitals and barracks, promotion of medical officers and the training of orderlies.

A good many years later, a writer said: "Had the conclusions which she reached been heeded in the Civil War in America, or in the Boer War in South Africa, or in the Spanish-American War, hundreds of thousands of lives might have been saved."

All of this work was done by a woman in delicate health, sometimes too weak even to sit up in bed. She had no staff of secretaries and typewriting was unknown, so almost all of her thousands of letters, the long, detailed reports and notes and the papers for newspapers and magazines were in her own hand.

She kept up a brave, even merry front. Through the letters, even some of the reports, runs a vein of delightful humor. However, when need arose, she could write stinging letters. Answering a friend who had scolded her for an especially forceful note, she said, "When I write civilly, I have a civil answer—and nothing is done. When I write furiously, I have a rude letter—and something is done (not even then always, but only then)."

In 1859 she drew up a plan for the Nightingale Training School for Nurses, which was eventually established at St. Thomas's Hospital in London. At about the same time, her Notes on Nursing was published. It stresses the importance of fresh air, sunlight, warmth, cleanliness, quiet and the right kind of food.

Another problem with which she was very much concerned was the condition of the English workhouses, the places where paupers (the penniless) were sent. Here the sick, the insane, the incurably diseased and children were all thrown together, cared for by pauper nurses. Actually it was hardly better than no care at all. In time, through the efforts of Florence Nightingale, laws were passed which provided for separate quarters, for sending the children to schools and forbidding the employment of pauper nurses.

THE IDEA OF TRAINED NURSING SPREADS THROUGHOUT THE WORLD

Meanwhile, authorities in many countries were writing to her for advice. Queens and princesses came to her little house for instruction. Gradually an organized system of trained nursing was introduced into all the British hospitals, and the idea spread throughout the world.

The last years of this great woman's life were intensely concerned with easing the suffering of the native people of India and of giving the best possible care to the British soldiers stationed there. However, the cause of one of the worst diseases in India, malaria, was not then known. She never visited India but corresponded with the most important officials in charge of Indian affairs.

She continued to write vast quantities of letters and notes until she was almost eighty years old. At last, Florence Nightingale herself had to have a nurse. But often, after the nurse had tucked her in for the night, she would get out of bed to tuck in the nurse. On August 13, 1910, this grand old lady fell asleep and did not wake up again.

Few men, and fewer women, have had such a wide influence. She was the founder of modern, skilled nursing. From an unskilled, almost despised employment, she lifted it to a place where service to mankind is recognized as its chief aim. The founder of the International Red Cross, Henri Dunant, said that he had been inspired by her. Florence Nightingale worked for a better world, and all of us share in the great service she gave her fellow-men.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 5817.

British Poetry of the 19th Century

Part II

Illustrated by Elinore Blaisdell

A Musical Instrument

By ELIZABETH BARRETT BROWNING
(1806-1861)

WHAT was he doing, the great god Pan,
Down in the reeds by the river?
Spreading ruin and scattering ban,
Splashing and paddling with hoofs of a goat,
And breaking the golden lilies afloat
With the dragon-fly on the river.

He tore out a reed, the great god Pan,
From the deep cool bed of the river:
The limpid water turbidly ran,
And the broken lilies a-dying lay,
And the dragon-fly had fled away,
Ere he brought it out of the river.

High on the shore sat the great god Pan,
While turbidly flowed the river;
And hacked and hewed as a great god can,
With his hard bleak steel at the patient reed,
Till there was not a sign of a leaf indeed
To prove it fresh from the river.

He cut it short, did the great god Pan,
(How tall it stood in the river!)
Then drew the pith, like the heart of a man,
Steadily from the outside ring,
And notched the poor dry empty thing
In holes, as he sat by the river.

"This is the way," laughed the great god Pan,
(Laughed while he sat by the river,)
"The only way, since gods began
To make sweet music, they could succeed."
Then, dropping his mouth to a hole in the reed,
He blew in power by the river.

Sweet, sweet, sweet, O Pan!
Piercing sweet by the river!
Blinding sweet, O great god Pan!
The sun on the hill forgot to die,
And the lilies revived, and the dragon-fly
Came back to dream on the river.

Yet half a beast is the great god Pan,
To laugh as he sits by the river,
Making a poet out of a man:
The true gods sigh for the cost and the pain,—
For the reed which grows nevermore again
As a reed with the reeds in the river.

Home-Thoughts, from Abroad

By ROBERT BROWNING (1812-1889)

OH, to be in England
Now that April's there,
And whoever wakes in England
Sees, some morning, unaware,
That the lowest boughs and the brush-wood sheaf
Round the elm-tree bole are in tiny leaf,
While the chaffinch sings on the orchard bough
In England—now!

And after April, when May follows,
And the whitethroat builds, and all the swallows!
Hark, where my blossomed pear-tree in the hedge
Leans to the field and scatters on the clover
Blossoms and dewdrops—at the bent-spray's edge—
That's the wise thrush; he sings each song twice over,
Lest you should think he never could recapture
The first fine careless rapture!
And though the fields look rough with hoary dew,
All will be gay when noontide wakes anew
The buttercups, the little children's dower,
—Far brighter than this gaudy melon-flower!

Requiescat

By Matthew Arnold (1822-1888)

Strew on her roses, roses,
  And never a spray of yew:
In quiet she reposes;
  Ah, would that I did too!

Her mirth the world required;
  She bathed it in smiles of glee.
But her heart was tired, tired,
  And now they let her be.

Her life was turning, turning,
  In mazes of heat and sound.
But for peace her soul was yearning,
  And now peace laps her round.

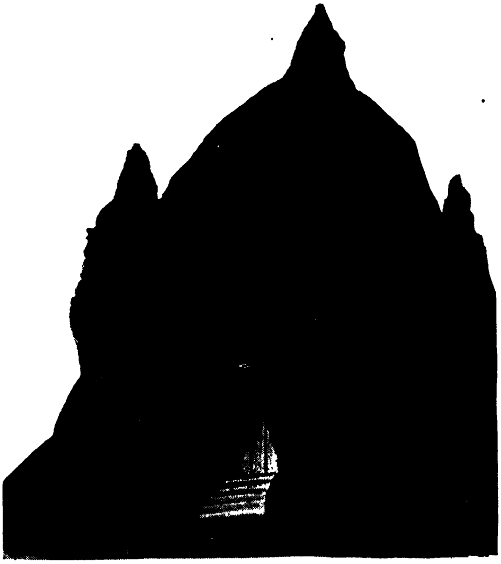
Her cabined, ample spirit,
  It fluttered and failed for breath;
Tonight it doth inherit
  The vasty hall of death.

"They Are Not Long"

By Ernest Dowson (1867-1900)

They are not long, the weeping and the
    laughter,
  Love and desire and hate;
I think they have no portion in us after
  We pass the gate.

They are not long, the days of wine and roses:
  Out of a misty dream
Our path emerges for a while, then closes
  Within a dream.



Uphill

By Christina Rossetti (1830-1894)

Does the road wind uphill all the way?
  Yes, to the very end.
Will the day's journey take the whole long
    day?
  From morn to night, my friend.

But is there for the night a resting-place?
  A roof for when the slow dark hours begin.
May not the darkness hide it from my sight?
  You cannot miss that inn.

Shall I meet other wayfarers at night?
  Those who have gone before.
Then must I knock, or call when just in
    sight?
  They will not keep you standing at that
    door.

Shall I find comfort, travel-sore and weak?
  Of labor you shall find the sum.
Will there be beds for me and all who seek?
  Yea, beds for all who come.

The Overland Mail

By RUDYARD KIPLING (1865-1936)

IN the name of the Empress of India, make
way,
O lords of the jungle wherever you roam,
The woods are astir at the close of the day—
We exiles are waiting for letters from home—
Let the robber retreat; let the tiger turn tail,
In the name of the Empress, the Overland
Mail.

With a jingle of bells as the dusk gathers in,
He turns to the footpath that leads up the
hill—
The bags on his back, and a cloth round his
chin,
And, tucked in his belt, the Post Office bill—
"Despatched on this date, as received by the
rail,
Per runner, two bags of the Overland Mail."

Is the torrent in spate? He must ford it or
swim.
Has the rain wrecked the road? He must
climb by the cliff.
Does the tempest cry "Halt"? What are
tempests to him?
The service admits not a "but" or an "if";
While the breath's in his mouth, he must bear
without fail,
In the name of the Empress, the Overland
Mail.

From aloe to rose-oak, from rose-oak to fir,
From level to upland, from upland to crest,
From rice-field to rock-ridge, from rock-ridge
to spur,
Fly the soft-sandalled feet, strains the brawny
brown chest,
From rail to ravine—to the peak from the
vale—
Up, up through the night goes the Overland
Mail.

There's a speck on the hillside, a dot on
the road—
A jingle of bells on the foot-path below—
There's a scuffle above in the monkeys'
abode—
The world is awake, and the clouds are
aglow—
For the great sun himself must attend to
the trail;
In the name of the Empress, the Overland
Mail.

The Toys

By COVENTRY PATMORE
(1823-1896)

MY little son, who looked from thoughtful
eyes
And moved and spoke in quiet grown-up
wise,
Having my law the seventh time disobeyed,
I struck him, and dismissed
With hard words and unkissed,
—His mother, who was patient, being dead.
Then, fearing lest his grief should hinder
sleep,
I visited his bed,
But found him slumbering deep,
With darkened eyelids, and their lashes yet
From his late sobbing wet.
And I, with moan,
Kissing away his tears, left others of my own;
For, on a table drawn beside his head,
He had put, within his reach,
A box of counters and a red-veined stone,
A piece of glass abraded by the beach,
And six or seven shells,
A bottle with bluebells,
And two French copper coins, ranged there
with careful art,
To comfort his sad heart.
So when that night I prayed
To God, I wept, and said:
"Ah, when at last we lie with trancèd breath,
Not vexing Thee in death,
And Thou rememberest of what toys
We made our joys,
How weakly understood
Thy great commanded good,
Then, fatherly not less
Than I whom Thou hast molded from the
clay,
Thou'lt leave Thy wrath, and say,
'I will be sorry for their childishness.' "

Pied Beauty*

By GERARD MANLEY HOPKINS (1844-1889)

GLORY be to God for dappled things—
For skies of couple-color as a brinded
cow;
For rose-moles all in stipple upon trout
that swim;
Fresh fire-coal chestnut-falls; finches' wings;
Landscape plotted and pieced—fold, fallow
and plow;
And all trades, their gear and tackle and
trim.

All things counter, original, spare, strange;
Whatever is fickle, freckled (who knows
how?)
With swift, slow; sweet, sour; adazzle,
dim;
He fathers-forth whose beauty is past change:
Praise Him.

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*From Poems of Gerard Manley Hopkins: by permission of Oxford University Press.

The Bugle Song

From THE PRINCESS

By Alfred, Lord Tennyson (1809-1892)

The splendor falls on castle walls
And snowy summits old in story:
The long light shakes across the lakes,
And the wild cataract leaps in glory.
Blow, bugle, blow, set the wild echoes flying,
Blow, bugle; answer, echoes, dying, dying, dying.

O hark, O hear! how thin and clear,
And thinner, clearer, farther going!
O sweet and far from cliff and scar
The horns of Elfland faintly blowing!
Blow, let us hear the purple glens replying:
Blow, bugle; answer, echoes, dying, dying, dying.

O love, they die in yon rich sky,
They faint on hill or field or river:
Our echoes roll from soul to soul,
And grow for ever and for ever.
Blow, bugle, blow, set the wild echoes flying,
Blow, bugle; answer, echoes, dying, dying, dying.

Prospice

By Robert Browning (1812-1889)

Fear death?—to feel the fog in my throat,
The mist in my face,
When the snows begin, and the blasts denote
I am nearing the place,
The power of the night, the press of the storm,
The post of the foe;
Where he stands, the Arch Fear in a visible form,
Yet the strong man must go:
For the journey is done and the summit attained,
And the barriers fall,
Though a battle's to fight ere the guerdon be gained,
The reward of it all.
I was ever a fighter, so—one fight more,
The best and the last!
I would hate that death bandaged my eyes, and forebore,
And bade me creep past.
No! let me taste the whole of it, fare like my peers
The heroes of old,
Bear the brunt, in a minute pay life's glad arrears
Of pain, darkness and cold.
For sudden the worse turns the best to the brave,
The black minute's at end,
And the elements' rage, the fiend-voices that rave,
Shall dwindle, shall blend,
Shall change, shall become first a peace out of pain,
Then a light, then thy breast,
O thou soul of my soul! I shall clasp thee again,
And with God be the rest!

The Garden of Proserpine

By Algernon Charles Swinburne
(1837-1909)

Here, where the world is quiet;
  Here, where all trouble seems
Dead winds' and spent waves' riot
  In doubtful dreams of dreams;
I watch the green field growing
For reaping folk and sowing,
For harvest-time and mowing,
  A sleepy world of streams.

I am tired of tears and laughter,
  And men that laugh and weep;
Of what may come hereafter
  For men that sow to reap:
I am weary of days and hours,
Blown buds of barren flowers,
Desires and dreams and powers
  And everything but sleep.

Here life has death for neighbor,
  And far from eye or ear
Wan waves and wet winds labor,
  Weak ships and spirits steer;
They drive adrift, and whither
They wot not who make thither;
But no such winds blow hither,
  And no such things grow here.

No growth of moor or coppice,
  No heather-flower or vine,
But bloomless buds of poppies,
  Green grapes of Proserpine,
Pale beds of blowing rushes,
Where no leaf blooms or blushes
Save this whereout she crushes
  For dead men deadly wine.

Pale, without name or number,
  In fruitless fields of corn,
They bow themselves and slumber
  All night till light is born;
And like a soul belated,
In hell and heaven unmated,
By cloud and mist abated
  Comes out of darkness morn.

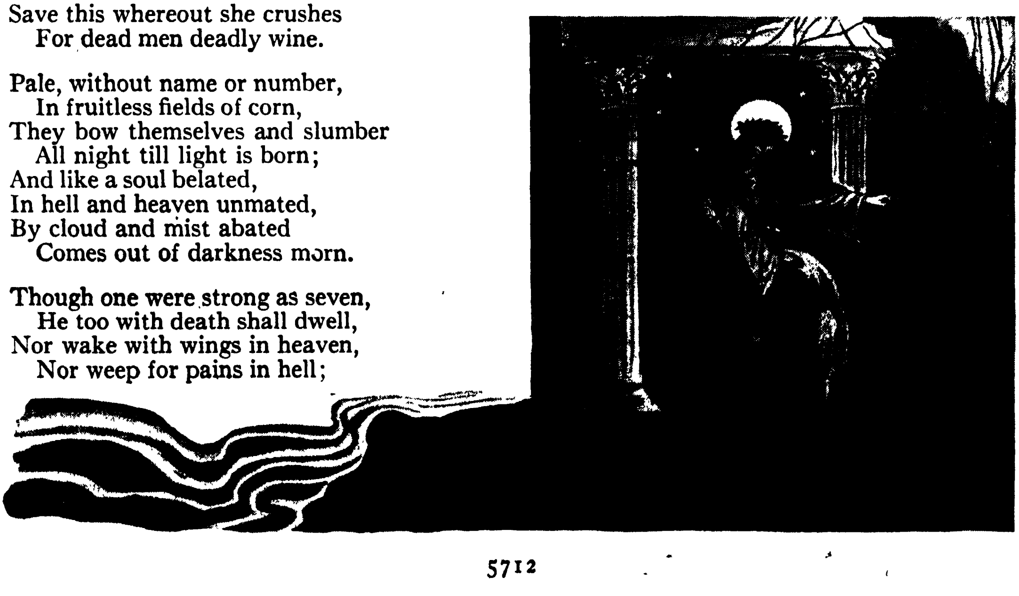
Though one were strong as seven,
  He too with death shall dwell,
Nor wake with wings in heaven,
  Nor weep for pains in hell;
Though one were fair as roses,
His beauty clouds and closes;
And well though love reposes,
  In the end it is not well.

Pale, beyond porch and portal,
  Crowned with calm leaves, she stands
Who gathers all things mortal
  With cold immortal hands;
Her languid lips are sweeter
Than love's who fears to greet her,
To men that mix and meet her
  From many times and lands.

She waits for each and other,
  She waits for all men born;
Forgets the earth her mother,
  The life of fruits and corn;
And spring and seed and swallow
Take wing for her and follow
Where summer song rings hollow
  And flowers are put to scorn.

There go the loves that wither,
  The old loves with wearier wings;
And all dead years draw thither,
  And all disastrous things;
Dead dreams of days forsaken,
Blind buds that snows have shaken,
Wild leaves that winds have taken,
  Red strays of ruined springs.

We are not sure of sorrow;
  And joy was never sure;
Today will die tomorrow;
  Time stoops to no man's lure;



And love, grown faint and fretful,
With lips but half regretful
Sighs, and with eyes forgetful
Weeps that no loves endure.

From too much love of living,
From hope and fear set free,
We thank with brief thanksgiving
Whatever gods may be
That no life lives for ever;
That dead men rise up never;
That even the weariest river
Winds somewhere safe to sea.

Then star nor sun shall waken,
Nor any change of light:
Nor sound of water shaken,
Nor any sound or sight:
Nor wintry leaves nor vernal,
Nor days nor things diurnal;
Only the sleep eternal
In an eternal night.

Song

By Sir William Watson (1858-1935)

April, April,
Laugh thy girlish laughter;
Then, the moment after,
Weep thy girlish tears,
April, that mine ears
Like a lover greetest,
If I tell thee, sweetest,
All my hopes and fears.
April, April,
Laugh thy golden laughter,
But, the moment after,
Weep thy golden tears!

Chorus from Atalanta in Calydon

By Algernon Charles Swinburne
(1837-1909)

Before the beginning of years,
There came to the making of man
Time, with a gift of tears;
Grief, with a glass that ran;
Pleasure, with pain for leaven;
Summer, with flowers that fell;
Remembrance, fallen from heaven,
And madness, risen from hell;
Strength, without hands to smite;
Love, that endures for a breath;
Night, the shadow of light;
And life, the shadow of death.

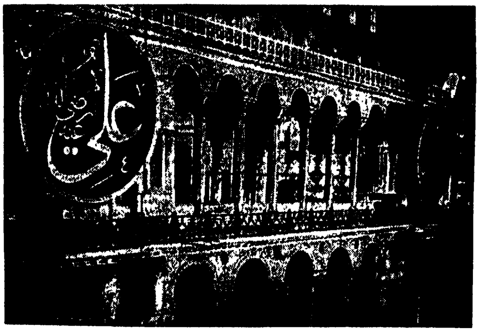
And the high gods took in hand
Fire, and the falling of tears,
And a measure of sliding sand
From under the feet of the years;
And froth and drift of the sea;
And dust of the laboring earth;
And bodies of things to be
In the houses of death and of birth;
And wrought with weeping and laughter,
And fashioned with loathing and love,
With life before and after,
And death beneath and above,
For a day and a night and a morrow,
That his strength might endure for a span,
With travail and heavy sorrow,
The holy spirit of man.

From the winds of the north and the south
They gathered as unto strife;
They breathed upon his mouth,
They filled his body with life;
Eyesight and speech they wrought
For the veils of the soul therein,
A time for labor and thought,
A time to serve and to sin;
They gave him light in his ways,
And love, and a space for delight,
And beauty and length of days,
And night, and sleep in the night,
His speech is a burning fire;
With his lips he travaileth;
In his heart is a blind desire,
In his eyes foreknowledge of death;

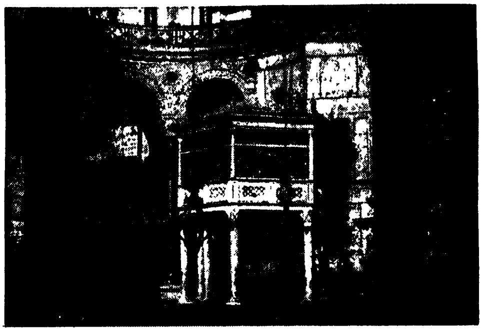
He weaves, and is clothed with derision;
Sows, and he shall not reap;
His life is a watch or a vision
Between a sleep and a sleep.

THE NEXT POEMS ARE ON PAGE 5822.

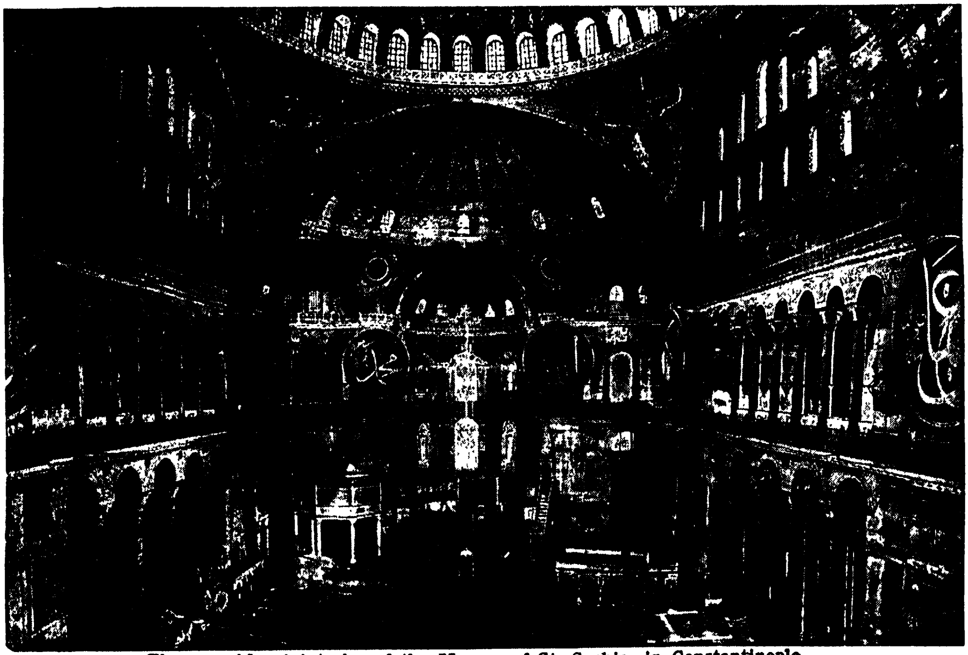
THE SPLENDID MOSQUE OF ST. SOPHIA



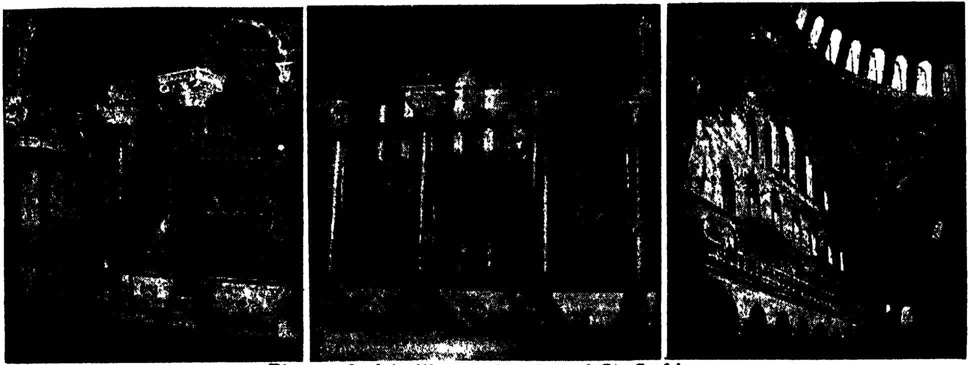
The façade of the second gallery.



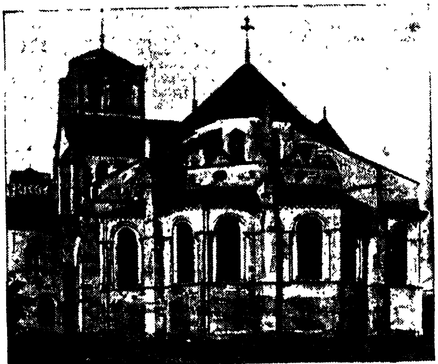
The imperial box in the nave.

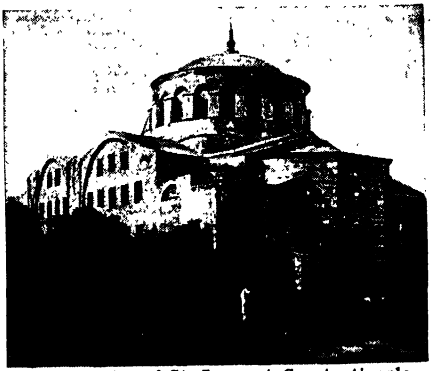


The magnificent interior of the Mosque of St. Sophia, in Constantinople.



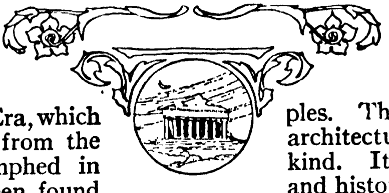
The wonderful pillars and arches of St. Sophia.


The apse of St. Madeleine at Vézelay.


The basilica of St. Irene at Constantinople.

ARCHITECTURE IN CHRISTIAN TIMES

THE THREE EARLIEST STYLES



WHEN we speak of Christian architecture we really mean all the work of the Christian Era, which may be said to date from the year the Cross triumphed in Rome. But it has been found necessary to make other classifications. We describe architecture as Romanesque, Gothic, Renaissance, Modern, and keep the term Early Christian for the work of some five hundred years in Europe—from the time of Constantine, who early in the fourth century made Christianity the religion of the Empire, to the days of Charlemagne.

When the Christians in Rome found themselves in favor after the bitter years of persecution and were told they might have churches of their own instead of hiding in the catacombs, they were somewhat at a loss as to where to start and what to do. They were poor and not very numerous, and Roman by birth. It was both natural and wiser for them to continue the Roman tradition. They built their first churches on the model of the basilicas, which we spoke of on page 5348. They used any material that came handy. Like the Saracen mosques, these churches were meeting-houses only. There was no necessity to build a central shrine for the figure of the god, as in the case of pagan temples. Thus this Early Christian architecture is of the simplest kind. Its interest is religious and historic rather than artistic. It was the cradle of a spiritual power that has no equal in history.

The basilican churches followed one general plan. They were long, rather low buildings, with flat timber roofs supported by rows of columns. Sometimes there were three aisles, sometimes five. Men sat on one side the central aisle and women on the other. This aisle was wider and rose higher than the others, and in the clear stretch of wall were set window spaces, generally filled in with blocks of pierced marble.

At the end of the centre aisle stood what was known as the arch of triumph, leading from the rectangular body of the church to its rounded-out end, or apse. There was generally a dome roof to the apse, studded with mosaics and shining glass. The high altar, under a canopy supported by marble columns, stood in the space called the sanctuary, between the arch of triumph and the apse.

Some of the basilicas must have presented a curious aspect when examined in detail, as the beautiful marble columns were taken from discarded pagan temples or baths, cut down to the right length, and strung together in aisles, regardless of varying moldings and carvings. But the general effect was of dignity, and the long vista of the central aisle gave an impression of length—an impression that was partly due to the unbroken lines of columns and partly due to the lowness of the roof.

CHURCHES WERE SET UP FAR AND WIDE AS CHRISTIANITY SPREAD

A good number of basilican churches were set up in Italy as Christianity grew in power. In Rome there were thirty-one; several in Ravenna; they rose in Constantinople, Jerusalem, Bethlehem; in Asia Minor, Egypt, Africa. The largest is St. Paul-outside-the-Walls, Rome, built in the fourth century and reconstructed after the fire that almost destroyed it in 1823. Other well-known Roman basilican churches are St. Clemente, St. Maria Maggiore, St. Agnes-outside-the-Walls. The most famous of the basilican churches are the two dedicated to St. Apollinare, in Ravenna; their wall mosaics are among the most beautiful in the world.

The early Christian architects had a great love for mosaics. Their predecessors, the Romans, had formerly used them for floor decoration only. In the basilican churches the Christians ornamented the walls wherever possible, and the apse domes shone down in a glory of blue and gold glass and lovely colors, full of light. The mosaics of the Ravenna churches were probably worked under Byzantine influence, of which we shall presently be thinking. In this city the Byzantine element became very powerful.

In the history of architecture two developments date from · this period: the bell-tower, or campanile, and the baptistery. From the Early Christian campanile grew the church towers of medieval Europe.

THE OLD PAGAN BUILDINGS USED BY THE CHRISTIANS FOR THEIR SERVICES

There was generally a baptistery—a separate building—attached to the principal church of a city, and at this time it was used only for the purposes of the rite of baptism. The baptistery was generally either circular or octagonal. It was built like the smaller Roman temples and tombs. A number of pagan buildings were taken over by the Early Christians for the purpose, and this is one of the most interesting cases of grafting the new on the old that the tale of architecture supplies. It was necessary that the baptistery should be large, as not only had it to serve for several churches, but the rite was administered only three times a year.

Very few baptisteries were built later than the eleventh century, and before that it became usual to place the baptismal font in the vestibule of the church. The three most important of the early days were at Rome, Nocera and Ravenna.

The architecture called Byzantine is really of the Early Christian period and was built for Christian worshipers, but it is of a very different character indeed from the basilican churches of Western Christendom. It dates from the time when Byzantium became the capital of the Roman Empire under the name of Constantinople.

Byzantium, standing on the border-line between Europe and Asia, was already an old city, long peopled by Greeks, when the Roman emperor Constantine made it the seat of his government. Upon the old town rose another that was the New Rome in more senses than one. It was against the instinct of any Roman emperor to take over a town and not impose on it at once something of Roman order, form and grandeur.

THE WONDERFUL NEW ROME THAT AROSE IN THE EAST

The New Rome, as Constantinople was also called, was swept and garnished; aqueducts and great pillared water cisterns built; magnificent buildings set up to house the emperor and his household and his army. Forums were laid out, six, one after the other, with a street that was the main artery of the town running through them. The most wonderful was naturally the Forum of Constantine. Thus was the old town, with its sloth, its decay, its vice, transformed into a Roman imperial city, the centre of a great commercial life, the pivot of a huge empire.

We remember from our chapter on Roman architecture that the forum was the heart of the town's life. This was true of the New Rome as of the old. But in New Rome there were changes. The Hippodrome, where chariot races were held, took the place of the Colosseum of Old Rome, with its gladiatorial fights, and Christian churches took the place of the pagan temples.

The earliest churches were of the basilican type, like those in Rome. The oldest that now exists of the many erected in Constantine's day and after is St. John of the Studium. But the basilican churches of Western Christendom had been built by the Romans, with plenty of fine discarded temples and baths to serve as quarries. In Constantinople, to begin with, the material at hand was poor—brick and concrete were all that could be relied on; marble and granite had to be imported. And the workmen and craftsmen were Greek. The spirit of old Byzantium, although its name was changed and Roman soldiers trod its streets, was nevertheless alive. Moreover, the East was always tapping at the door, so to speak. These two influences, Greek and Asiatic, presently became powerful.

HOW BYZANTINE ARCHITECTURE SLOWLY DEVELOPED FROM THE ROMAN

The change was gradual. It was not as if one day, or one year, a pure basilican church was set up, and the next a pure Byzantine. A little more of a feeling for many-domed roofs covering buildings on a square plan, a little less for rectangular aisles and flat roofs, a little more gorgeousness and a little less severity, and the transformation was complete. Two hundred years after Constantine built his first church, St. Sophia, often called the glory of early Christendom, arose.

This famous building, later a Turkish mosque, and now a museum, is the finest thing Byzantine architecture produced. St. Sophia marks the point of perfection which an art once may reach but never recapture. It stands isolated, unique, in the history of the world.

Byzantine architecture has never died out; it is the natural expression of the Greek branch of the Christian Church which has been strongest in Russia and Eastern Europe. There are fine Byzantine churches in Kiev, Moscow, Leningrad; some in Serbia and Greece; several in southern Italy and in Asia Minor. From time to time churches are still built in the Byzantine manner: the Roman Catholic Cathedral, Westminster, is a modern example. During the last generation a number of Byzantine buildings have risen in America. But in no instance has the lofty beauty of St. Sophia been even distantly rivaled.

THE GLORIOUS DOMED ROOF OF THE MOSQUE OF ST. SOPHIA

Greek architecture carried to perfection the principle of the square (trabeated) openings and pillar-supported roofs; Gothic architecture, as we shall presently see, developed to the highest genius the principle of the vaulted roof; in St. Sophia is the finest example of the domed roof, which was the chief glory of Byzantine architecture.

The emperor Justinian caused St. Sophia to be built toward the middle of the sixth century. Its architects were Anthemius of Tralles and Isodorus of Miletus, both Asiatic Greeks. The church is square in plan. Over its central space rises the great dome, 107 feet in diameter, and against its sides, so to speak, each leaning against each other and keeping each other up, are the half domes and quarter domes that roof in the rest of the huge building.

Inside, the general effect is of one enormous rounded shape that hangs over and cups in the mass of the interior which appears like one great oval nave. The effect of this unique doming is one of extraordinary lightness and ease. The eye runs along its lines and back, and is not arrested by ugly supporting masses. An ancient writer described the Church of St. Sophia as being crowned by a canopy that rested in its place of its own accord, as if suspended by a chain from the skies.

Part of the great charm of contour that marks the interior of St. Sophia is due to the good judgment of its architects, who knew that a dome rising too high, so that the eye is wearied in following its lines, is false to the principle of beauty in dome construction. They therefore kept the dome shallow and covered it with gold inset with mosaic pictures of apostles and saints.

THE BRILLIANT LIGHT THAT COMES THROUGH FORTY WINDOWS

Round the lower part of the great dome are forty small windows, twelve on the walls and others in the subsidiary domes, and through these openings the brilliant light of the East creeps in and sheds a white radiance over the heavy richness of the interior. The walls and piers are lined with sheets of marble—white, green, blue and black. Long rows of stately columns of many-colored marble support the galleries that run round the church. Pattern mosaics cover the floor.

The Turks, transforming the Christian church into a Mohammedan mosque, covered up or plastered over many of the mosaic pictures, in some cases hiding them under texts from the Koran. In the lovely apse, where the figure of Christ, brilliantly inset in mosaics, once gleamed from the roof, they set their Mihrab, the niche that points to Mecca.

The Mohammedan invaders added also the four minarets that close in the outer buildings of St. Sophia, plastered over and washed the brickwork of the church in the horizontal bands of color they so much liked, and destroyed the pillared entrance court leading to the arcaded porch of the church. Thus, from the outward appearance of St. Sophia to-day one would not guess the perfect beauty within.

In actual technique of construction this famous church may be taken as an example of all Byzantine architecture. Since the Turkish capital was removed to Asia, it was decided to restore St. Sophia to its original form as an example of Byzantine architecture.

The earlier Byzantine architecture was generally more interesting in the interior than the exterior. The domes were built so as to be beautiful to the worshipers in the church. They were not too high. The result was that, seen from the outside, walls and roofs had a curiously compressed look, as if something had been flattened down. This is all the more evident to a European accustomed to the tall spire and towers of Gothic architecture. To an Eastern, bred in countries where buildings are flat-roofed, with long, blind walls pierced by small windows set high above the ground, this closed-in appearance seems natural.

THE BYZANTINE BUILDINGS WHICH INSPIRED ST. MARK'S AT VENICE

There were many other Byzantine churches in Constantinople; some have been converted to mosques, some destroyed by time and enemy hands. St. Irene is a beautiful church; another, called St. Saviour of the Chora, is known as the Mosaic Mosque because of the exceeding richness of its interior. It also has an interest in that its façade was copied when the Church of St. Mark was built in Venice. The real model of St. Mark's was a very fine Byzantine building called the Church of St. Saviour, in Constantinople, and the plan of this church was also copied when St. Front was built at Périgueux.

St. Mark's, Venice, is one of the most famous churches of medieval Europe. It was built about the eleventh century on the site of a basilican church whose rectangular plan was changed, in the new building, for that of a Greek cross. The church has five domes, the chief one over the centre of the building and one on each arm of the cross. The mosaics of the interior are very wonderful. So cunningly is the church built, wall and pier sliding into dome, that the mosaics seem to run in unbroken contour around its walls. It would seem that the builders had thought much less of the fabric of the church than of this gorgeous display.

The exterior, with its five portals facing the piazza of St. Mark, is one lovely mass of architecture and ornament of varying periods, of shining marble, alabaster, mosaic and gold bands. Many countries and generations gave of their treasures to St. Mark's, and the soft light of the sky and the sea's reflected radiance add a peculiar beauty of their own.

THE PRIDE OF THE VENETIAN PEOPLE IN THEIR BEAUTIFUL CITY

Venice, a powerful republic in her great years, was in a position to take what she wanted, practically speaking, from anywhere. Her traders went near and far, east and west. The pride of the Venetians in their city was unbounded; no wealth was too great to spend on it. They were also an extremely independent people, and though they borrowed the plan of St. Mark's from a pure Byzantine church, they refused to be bound by any laws of established taste. And here we ourselves can learn a lesson of judgment.

We have spoken of the logic and perfect taste of the Greeks. They developed a style of architecture and kept within the bounds imposed by the style. Thus they produced that master-work the Parthenon. The Byzantine architects developed another style and kept, with equal logic and taste, within its limits. Thus they produced that other master-work St. Sophia's. The creators of these marvelous temples knew that in a great edifice one cannot play tricks. If a style is chosen it must be adhered to, and not a single inharmonious line added to the design.

MATERIAL FROM THREE CONTINENTS FOR THE MAKING OF ST. MARK'S

When the people of Venice built St. Mark's it was suggested to them that, having begun on a pure Byzantine model, the church should be so finished. But this seemed to the proud republicans to savor of a loss of liberty. They were not going to be dictated to by anyone: they would build their church as they wished. The ships of Venice swept the eastern seas and brought back from Alexandria and Asia Minor great columns of porphyry and alabaster, blocks of marble for facing. The bronze horses from Nero's arch in Rome came to decorate the front of St. Mark's. Presently "bonnets" were put on the domes. When the Gothic spirit invaded Italy, arches, pinnacles and niches were added to the pile. The result is that St. Mark's has a whimsical and alluring loveliness of its own, but can never rank among the great.

In spite of its beauty, there has always been something too luxurious and unnatural in Byzantine architecture. The gorgeousness of the mosaic-lined interiors may have stifled its life. Figures made of small cubes must needs be a convention, and in too many conventions art cannot live. In any case, the pure Byzantine style is most suited to brilliant climates where large windows are unnecessary.

While this architecture was forming itself in the East, certain changes were taking place in Western Europe, where the Christian Church was growing in power and the empire of Rome crumbling. The dawn of a new day of letters and art was ushered in by the founding of the monastic orders. These presently became very powerful bodies, every generation or so needing new monasteries and churches. All that there was of learning and art in medieval Europe was implanted there by the monks. They were not only the schoolmasters of the continent, they were its architects. It was not until the twelfth century that any secular art or architecture arose.

THE STAMP OF OLD ROME ON THE FACE OF EUROPE

Rome had left her unmistakable stamp on all the European towns she had conquered, and though the empire was gone, her work remained—monuments, bridges, buildings; for many centuries her roads were the chief highways of Europe. And although Eastern influences, through traders and travelers, took root here and there, the finest thing in Europe was the handiwork of old Rome. So that when the new faith, ever increasing, groped for an expression in architecture that would improve on the primitive basilican churches, it still seemed best to cling to the ideas of Rome.

Basilican churches had been at their best a makeshift. They were unsatisfactory chiefly on account of their timber roofs, which so easily exposed the whole building to danger of fire. In discarding them architects were faced by a new difficulty. If they made flat stone roofs instead of wooden ones it meant the conveyance of very large blocks of stone or marble for the purpose; and this they could see might be done once or twice, but in general practice would kill all architecture except in districts that were rich in material.

These early builders found the solution of their difficulties in the simple vaulted roof carried by round arches, which could be made of small stones almost anywhere. As this style of roofing developed, the square-headed doorway and window was discarded for the round-headed opening. This feature, the round arch, formed the prevailing characteristic of the new architecture, which presently became known as Romanesque. The influence of the old pagan style soon waned and died. Rome and Greece were forgotten; became ghosts that lay very still for several centuries.

THE ROMANESQUE CHURCHES BUILT ON THE PLAN OF A CROSS

Romanesque architecture grew in France, Italy, Germany; it came to England by way of the Norman Conquest, and is generally known there as Norman.

The plan of the Romanesque church was a development of the basilican, which was a rectangle with the apse thrust out at the eastern end. An arch of triumph, we remember, had divided the sanctuary, or the place where the altar stood, from the body of the building. In the Romanesque plan the sanctuary was lengthened into the chancel, or choir, and was divided from the rest of the church by a screen. In front of the chancel screen, on each side of the central aisle, or nave, about two-thirds down the length of the church, short arms were thrown out, making transepts. The plan thus became that of a long (Latin) cross, and we can see, in its development from the plan of the basilican church, the first of the changes that led to the more complicated plan of the Gothic church.

As the shape of the building altered in this way, the first of the spires and towers that are such features of our sacred architecture appeared—a development, we remember, from the campanile, or bell-tower. They were thrown up from the body of the church either at the east or west end, or above the place where the transepts crossed the nave.

The many-apsed church appeared as Romanesque architecture developed. Instead of the centre aisle being thrust out to form the apse, and the side aisles ending at a square wall, each aisle had its apse, and the transepts on the eastern face were rounded out too. The French developed the apse to an extraordinary extent. They had a strong feeling for the thrust-out shapes, or bays, from the eastward end of the church, and presently conceived the idea of throwing out a number of bays, like little apses on the chief apse itself, so that in plan it looks like half an enormous rosette. This kind of treatment of the eastern end of a church was called "chevet," and it continued long after Gothic supplanted Romanesque. The only complete chevet in England is formed by the little chapels that radiate from the apse of Westminster Abbey. A good example in New York is to be found in the new Cathedral of St. John the Divine. Here there are seven chapels radiating from the choir.

In some churches an aisle was run round the eastern end, between the chancel inclosure and the apse wall, and was called the ambulatory, where men could walk about and meditate. We can see this feature in many English cathedrals and churches to-day. One, belonging to the Romanesque period, is that of St. Bartholomew, Smithfield.

This kind of arcaded walk brings us to the subject of cloisters—open spaces set with pillars of varied beauty, and cloistered buildings generally.

The great builders of Europe, as we have said, were the monks. The monasteries and abbeys were the centres of interest and power in whatever province and country they arose, and some of their buildings were of very great dignity. We have produced more graceful, light and beautiful buildings, but nothing so imposing as the medieval monasteries.

The honors of architecture are generally accorded to the monks of the Cluniac Order, founded in 909. This great community of scholars and artists were among the first benefactors of Europe. Their huge and magnificent Abbey church at Cluny, near Lyons, was one of the most famous buildings in the world. It took forty years, about the end of the eleventh century, to build, and after giving joy and inspiration to men for seven hundred years, was torn down by the citizens of Cluny in Revolutionary frenzy.

The church, as we can well understand, was the centre of every monastic establishment. On it the monkish artists spent their many talents, and in many cases very real genius. Around the church, like houses about a village green, clustered the rest of the buildings that were necessary for the life and maintenance of a large and inclosed and self-supporting community.

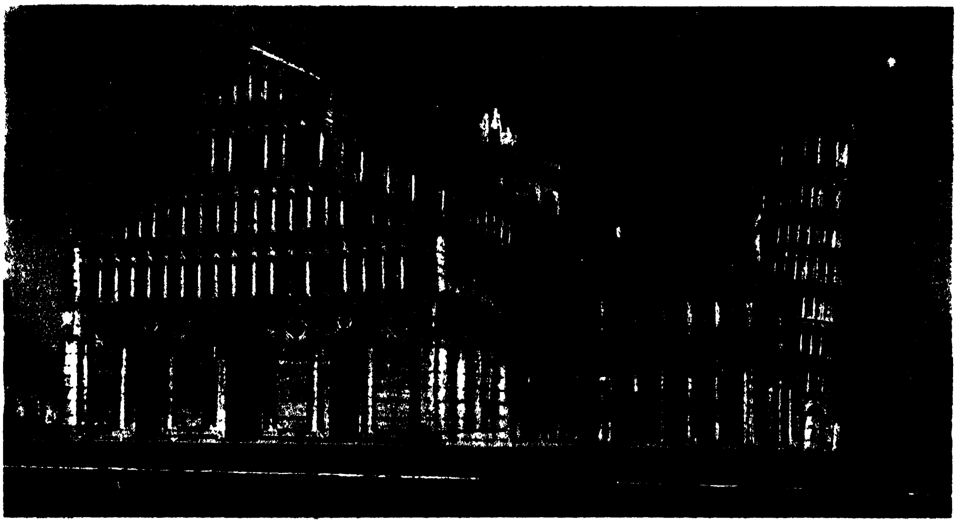
The cloister court separated the church from the kitchens and dining-halls, and this pillared space added a dignity of its own to the sacred building. In addition to the actual dwellings of the monks, which contained interesting apartments like those set apart for the brothers who were illuminating manuscripts, there were the guest houses, infirmary, prison or punishment cells, stables, granaries, bakehouse, mills, workshops. All these buildings were nobly set up in the Romanesque style.

There are remains of monastic settlements like these at Fountains Abbey in Yorkshire, England, where one can walk through the ruined spaces and picture the busy, ordered, monastic life that flourished there from its founding in 1132 to its break-up in the sixteenth century by the order of Henry VIII.

These great masses of buildings had naturally a great effect on the architecture of the day. Cluny Abbey church is said to have served for a model of all Europe, and been imitated even in the Holy Land. All over France memorable and sacred buildings arose, set up by the monks of various orders. To go from one to the other is to follow a trail of beauty for whose creation we shall never cease to be thankful.

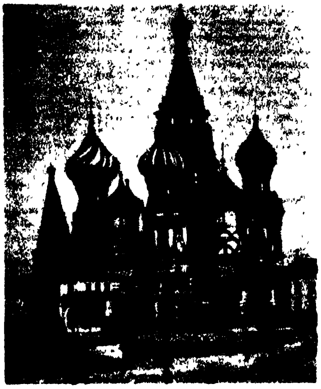
Architecturally, the river Loire seemed to divide France in half. South of the river is the greater richness, where the Cluniac influence was strong, and also

THREE GREAT STYLES OF BUILDING



THE IMPRESSIVE CATHEDRAL OF PISA AND THE LEANING TOWER

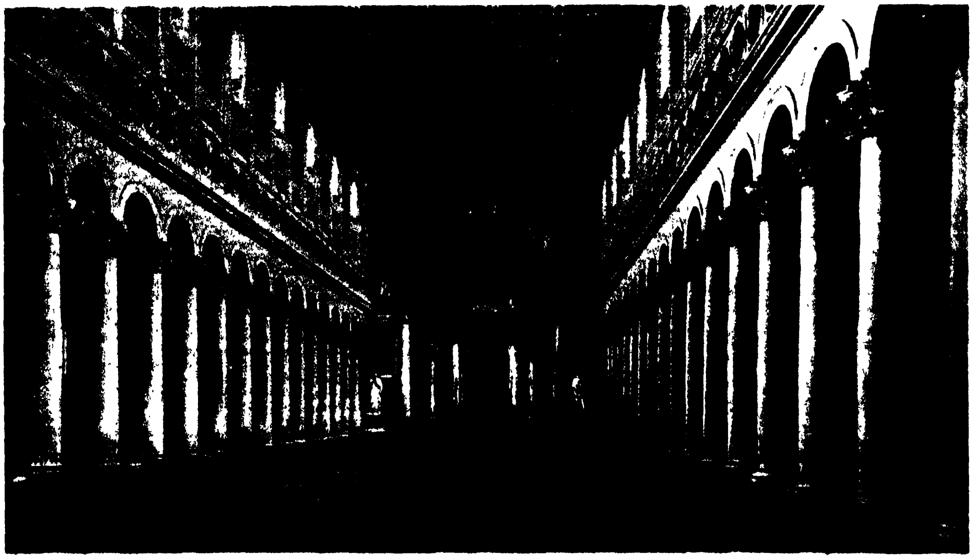
THE CATHEDRAL OF ST. MARK'S AT VENICE



THE CHURCH OF ST. BASIL AT MOSCOW

THE ROMANESQUE TOWER OF ST. PORCHAIRE CHURCH, POITIERS

THE CATHEDRAL OF THE RESURRECTION AT LENINGRAD



THE SPLENDID INTERIOR OF THE BASILICA OF ST. PAUL-OUTSIDE-THE-WALLS AT ROME

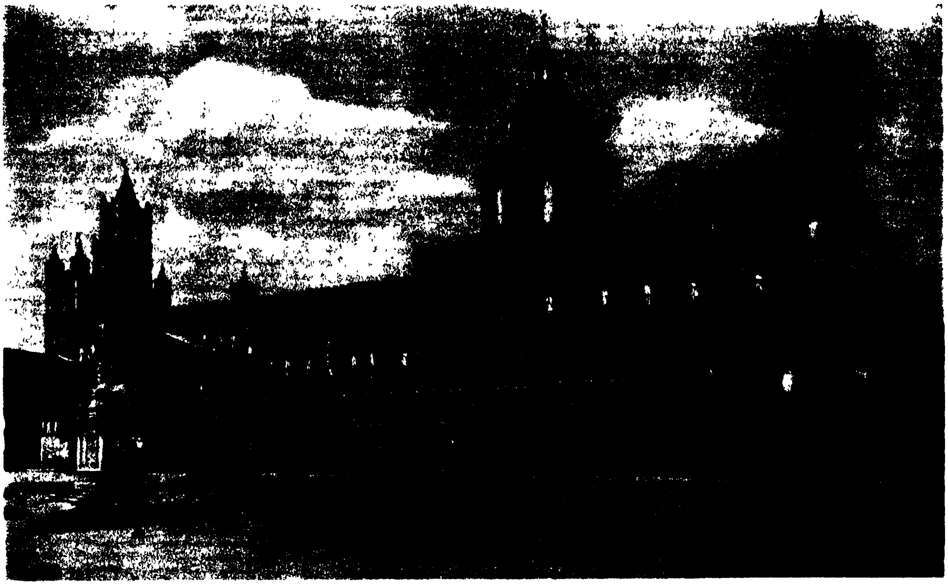
ST. APOLLINARE NUOVO AT RAVENNA

THE DOORWAY OF ST. MARK'S AT VENICE

THE CHURCH OF LA MARTORAN AT PALERMO

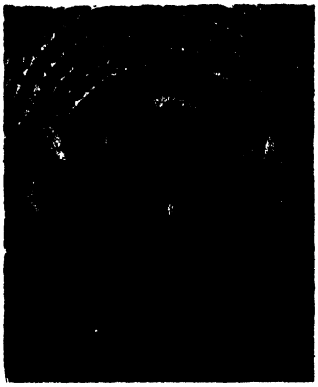
THE SOUTH SIDE OF AIX-LA-CHAPELLE CATHEDRAL

THE CHURCH AND MONASTERY AT DAPHNE, IN GREECE

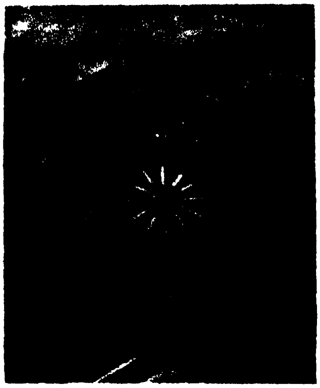


THE SPLENDID CATHEDRAL AT PALERMO

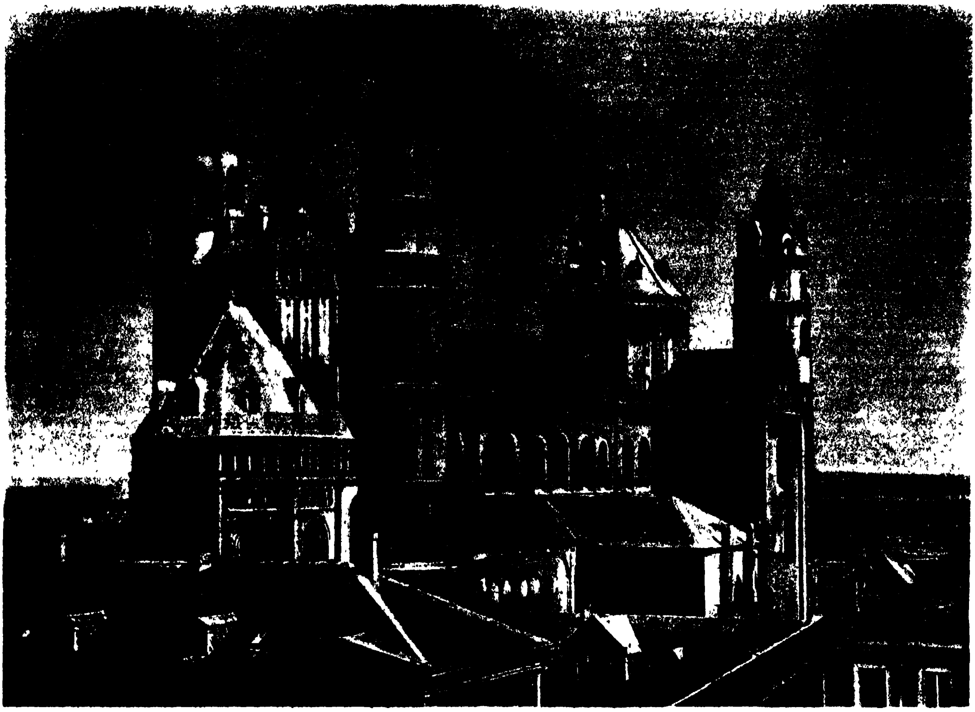
A ROMANESQUE CAPITAL AT MONREALE



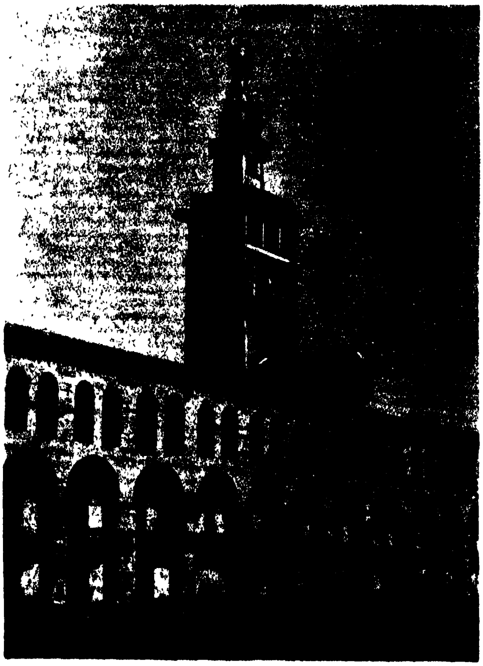
THE INTERIOR OF THE CATHEDRAL AT AVIGNON



A WINDOW OF ST. AGOSTINO CHURCH, PALERMO



THE CATHEDRAL OF WORMS, IN GERMANY



CLOISTERS OF THE GREAT MOSQUE, DAMASCUS

THE CHURCH OF ST. SERNIN AT TOULOUSE

The pictures in these pages are reproduced by courtesy of Messrs. Alinari, E.N.A., Mansell, McLeish, and others.

where Byzantine and pagan beauties still exerted a power. There were lovely capitals and columns to be had from discarded Roman buildings, fine masses of stone and marble. These churches of the south were consequently marked by most beautiful cloisters and very rich façades, or fronts. There were generally three doorways, each surmounted by, not one rounded outline, but many; arch after arch falling back into the thickness of the wall, each with its pillar and carved capital.

There is something in the shape of the pure Romanesque doorway that no later architecture has achieved. It may be the exceeding charm of the low swing of the arch, from point to point of which the eye goes and comes, and is conscious of restfulness, of repose, of something returning upon itself, in Nature's mysterious way. People who watch the sea feel just the same kind of magic in the semicircular, swinging trough between two wave crests.

WHY THE BUILDINGS OF NORTHERN FRANCE ARE SO SEVERE

In the north of France, where the thoughts of architects were not so much affected by the richness of an earlier empire, the buildings were sterner, more severe. There are very few anywhere whose fabric is not touched in some part by so-called improvers of a later era. North of the Loire the most important Romanesque buildings are the two Abbey churches of Caen—l'Abbaye-aux-Dames, founded by Matilda, wife of the Conqueror, and l'Abbaye-aux-Hommes, also known as St. Etienne, begun by the Conqueror himself.

Near Paris is the Abbey church of St. Denis, on which a fine early Gothic architect, Abbé Suger, worked. St. Germain-des-Prés has managed to maintain its Romanesque look through many intervening centuries. South of the Loire are many wonderful piles like those of St. Madeleine, at Vézelay; St. Gilles and St. Trophime, at Arles; Notre Dame, at Avignon; St. Sernin, at Toulouse; and Angoulême Cathedral.

In Italy the greatest triumph of the Romanesque period was the famous group at Pisa—the cathedral, the circular baptistery, and the campanile known as the Leaning Tower. In Sicily the fine cathedral of Monreale, near Palermo, shows a mixture of Early Christian, Byzantine and Romanesque influence. San Miniato, in Florence, San Michele, in Pavia, San Zeno Maggiore, in Verona, and the Baptistery at Cremona show respectively the varying appearance of Italian Romanesque architecture. Here the basilican influence lingered far longer than it did north of the Alps.

THE CHURCHES IN GERMANY BUILT ON EARLY CHRISTIAN LINES

A certain amount of Romanesque architecture appeared in Germany, principally in Saxony and the Rhineland. Charlemagne forced the Saxons to become Christian, and hence in this province a number of baptisteries were built on Early Christian lines. Circular churches arose with the sanctuary thrown out at the end.

Charlemagne had a strong feeling for architectural beauty, and he strove to awake in the German provinces something of the impulse for building fine churches that was so strong in Southern Europe.

The Cathedral at Aix-la-Chapelle rose at his orders, Charlemagne foreseeing that this building might presently serve as his tomb-house; and it would have been a fine record of Romanesque work if it had not been so much altered and improved in successive centuries. The original quaint polygonal body of the church remains, and architects think that it was probably modeled on San Vitale, Ravenna.

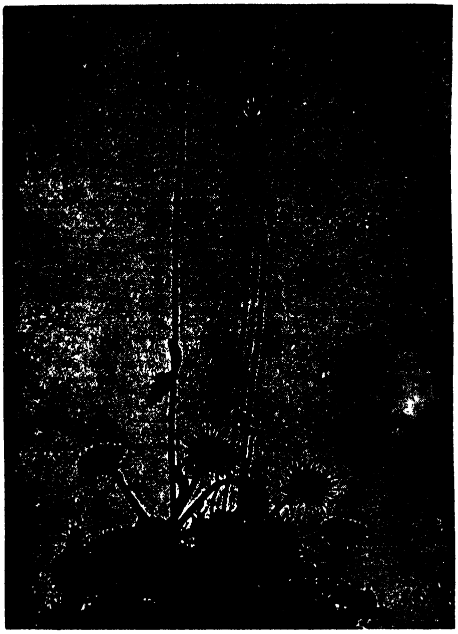
A PECULIAR FEATURE OF GERMAN ROMANESQUE ARCHITECTURE

One of the peculiarities of German Romanesque architecture is the double-apsed church—that is to say, a church with an apse both at the east and at the west end. Gernrode Abbey is the first built in this way. In other countries, apses were used in the east end only, and thus the western end of the church could be devoted to the entrance façade. German architects placed their portals in the side of the church and richly ornamented them. And as they early showed their liking for round and octagonal turrets and many-sided domes, their buildings of this period are more picturesque than dignified.

The cathedrals of Worms, Spires and Mayence are typical of the German feeling. The cathedral at Trèves is an interesting church in an interesting city.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 5963.

FOUR INTERESTING MARSH PLANTS



THE ROUND-LEAVED SUNDEW

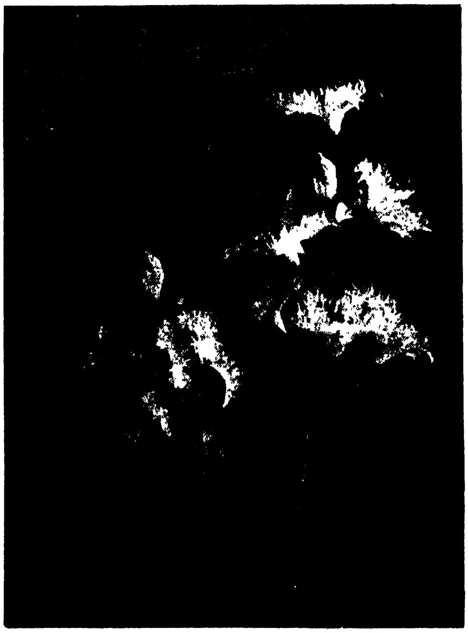
An odd-looking insect-eating plant which catches and holds its prey prisoner by means of a sticky substance secreted by the leaves.

THE COMMON BUTTERWORT

This is another of our insect-eating plants. The frosted-looking leaves and the violet flowers give a striking appearance. It grows in the North.

THE BLACKBERRY

The blackberry blossom discloses its family relationship by its likeness to a single rose with white crumpled petals. The flowers are sceptless and very abundant.



THE BUCK-BEAN

The Buck-bean, also called the Bog-bean and the Marsh Trefoil, is one of the handsomest flowers of the bogland. Its flowers are white, tipped with pink, and as many as twelve grow on one spike.

THE FLOWERS OF THE MARSHES

To some extent the flowers of the bog and marsh are the same as those of the streamside. This, of course, is only what one would expect when it is considered that the reason for their existence in either place is their liking for abundant moisture at the roots.

Botanists call them *hydrophytes,* or water plants; while those of the uplands are mostly *xerophytes,* or dry plants; and those of the hedgerow, field and wood are mainly *mesophytes,* or medium plants, because they like a soil that is neither too wet nor too dry. Therefore, when we are hunting for flowers around boggy land, we must not be surprised if we again meet with old friends of the streamside.

The soil of the bog is mainly peat, which is composed of the remains of plants that have grown on the spot. In most bogs we shall find a certain kind of moss known as Sphagnum, or Bog-moss, which grows in great quantities, the branches of each plant loosely interlocking with those of its neighbors, so that they become like a huge sponge, holding much water. If we pull up a handful of bog-moss and squeeze it, we shall get a clear idea of this. The bog-moss grows to a great length, always fresh green at the top and dead at the bottom. The pressure of the new growths upon the old gradually turns the lower part into peat, which fills up the wet hollow where the bog began. When dried, peat makes good fuel, but just now we are more interested in the flowers that may be found in the bogs and in marshy places. The bog-moss is not a flowering plant; but we may be interested in looking for its fruits, which are red and round, about the size of a medium-sized shot, standing on slender stalks above the plant.

Among the most curious of the bog plants are the Sundews. As flowering plants they are not very striking, for their blossoms are small and white. In this case it is the leaves that awaken our interest and wonder. We have several kinds—as the oblong-leaved, the spatulate-leaved and the thread-leaved sundews. The round-leaved sundew has a small rootstock and not much in the way of roots; but little more than is needed to hold it securely in the soil.

It has other means of getting its food, as we shall see. From the rootstock all around range a dozen or more leaves on long hairy leaf-stalks. The leaf proper is sometimes half an inch across, while the leaf-stalk frequently measures an inch and a half long. The round leaf-blade is studded all over with long crimson filaments, with a glandular knob at the tip of each. From this knob there is poured out a clear sticky fluid, which can be drawn out into long threads as though it were a very good sort of liquid gum.

This gum, as we may call it, glitters in the sunshine, and, in combination with the red color of the leaves, makes these appear more like flowers sprinkled with dewdrops. They also look not unlike small sea-anemones, though it is not likely that they present such an appearance to the insects that visit them; but their action is much like that of an anemone.

Now, the sundew is so clever that it can tell the difference between things that will serve it as food and things that will not. If upon a fully open leaf we drop a particle of stone or glass, nothing will happen, which shows that the leaf has got some sense of taste or smell. But if we were to drop upon it the smallest fragment of meat, or even a snippet of hair, it will know that the substance is *animal,* and will bend its tentacles toward it and envelop it.

THE WRINKLED FOLIAGE OF THE HAIRY BONESET

The great grayish hairy Boneset is a striking plant of wet places. Its deeply wrinkled foliage and great flowering tops, made up of tiny dull white florets in little heads, were utilized by country folk as a favorite medicine, perhaps aiding the setting of bones by keeping the patient in good health. Its other name, Thoroughwort, refers to the way in which the tall stem appears to pierce the centre of a long, double-pointed leaf—an appearance caused by the union of the bases of a pair of exactly opposite leaves.

THE WHITE-FRINGED FLOWER OF THE BUCK-BEAN, OR BOG-BEAN

One of the most lovely of these little-known bog flowers is the Buck-bean, or Bog-bean. We shall know it at once if we remember its name, *Menyanthes trifoliata,* because its large leaves are broken up into three leaflets, and look like the leaves of the broad bean. These leaves come from a thick, creeping rootstock, from the middle of which rises a stout flower-stem bearing white or pink funnel-shaped flowers, the lobes of the corolla covered with fleshy fringes which give them a peculiarly delicate and feathery appearance, and the stamens red. These should be sought from May to July in the long grass of the swamp.

THE YELLOW MARSH-MARIGOLD, OR KINGCUP

If our visit to the bog is in spring, we shall find parts of it turned to gold by the rich yellow flowers of the Marsh-marigold. This is one of the Buttercup Family, as we shall soon see by the flowers. They are like huge buttercups, two inches across. There is a thick, creeping rootstock that roots as it goes, and sends up thick stems and large glossy kidney-shaped leaves that increase in size after flowering.

The flower has no petals, but the sepals are colored and enlarged, and serve as well as petals. There are many golden stamens, and nectar is poured out abundantly at the base of the pistils, and attracts beetles, flies and bees. Another name for the marsh-marigold, given to it in many districts, is the Kingcup.

THE LILAC-COLORED FLOWERS OF THE MARSH-VIOLET

About the same time we may find the Marsh-violet in flower. Its leaves are broader than those of the sweet and dog violets, more kidney-shaped than heart-shaped, and the lilac-colored flowers stand high above the leaves on very erect stalks. They are not scented, and are sometimes white. The arrangements of the flower are much the same as in the case of the other violets.

THE BLACK SNAKEROOT, SOMETIMES CALLED BLACK COHOSH

The Black Snakeroot, or Black Cohosh, shoots up in dark woods, as tall as a man. Its thick, knotted, fibrous roots are used in medicine. The leaves are made up of many small leaflets, and the tall flower-stalks are slender, pointed, and studded with delicate white tufts, which one may discover to be clusters of thread-like stamens thrust out from flowers, whose sepals and petals are so small as to be hardly noticed, or have fallen away.

THE FERN-LIKE MEADOW-RUES AND DELICATE SPIRÆA

A group of herbs, the Meadow-rues, is so called from a similarity in their delicate, fern-like foliage, made up of small leaflets, to that of the garden-rue. They bear great branching clusters of tassel-like little flowers in which only the quivering groups of long stamens are noticeable. One kind blooms early on rocky hillsides, while another, with snowy white flowers, rears them high in meadow-lands, on very wet places.

FLOWERS OF THE MARSHES

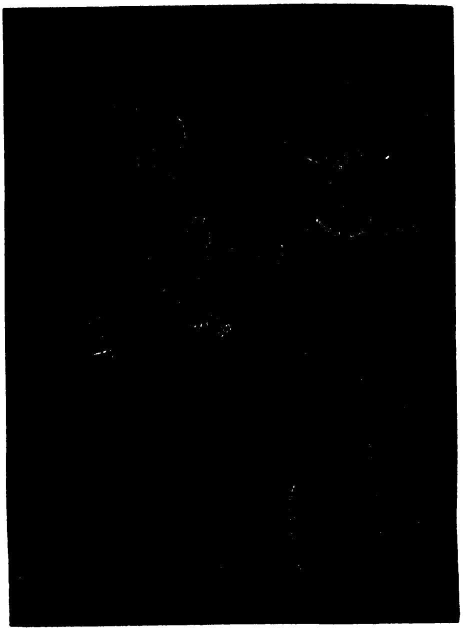
The Marsh-marigold
In boggy and marshy places the marsh-marigold, with its bright yellow flowers, is a conspicuous plant. After the plant has flowered, the leaves increase.

The Marsh-violet
The flowers of the unscented marsh-violet, which grows principally in the North, are paler than those of the sweet violet. They are either lilac or white.

The Hairy Boneset
The boneset, or thoroughwort, was a medicinal plant of high repute with our grandmothers, who would gather it for their healing tea.

The Meadow-rue
The meadow-rue takes its name from its resemblance, in leaves, to the rue of our gardens. The name rue is old and its derivation obscure.

The Syringa
The fragrant syringa is a native of Central Europe. It has escaped from gardens in Virginia and Ohio, and sometimes in central and eastern United States.



The Grass of Parnassus
This beautiful plant is not a grass, but a member of the saxifrage family. The heart-shaped leaves grow on long stalks; the flowers are white.

The Chokeberry
The chokeberry, a near relative of the meadowsweet, is most often found on the edges of ponds. Its berries are edible but dry and choking.

The Turtlehead
The curious white flowers of this plant look like the head of a turtle, and hence the name; and like its namesake, the plant is to be found in wet places.

The Bird's-eye Primrose

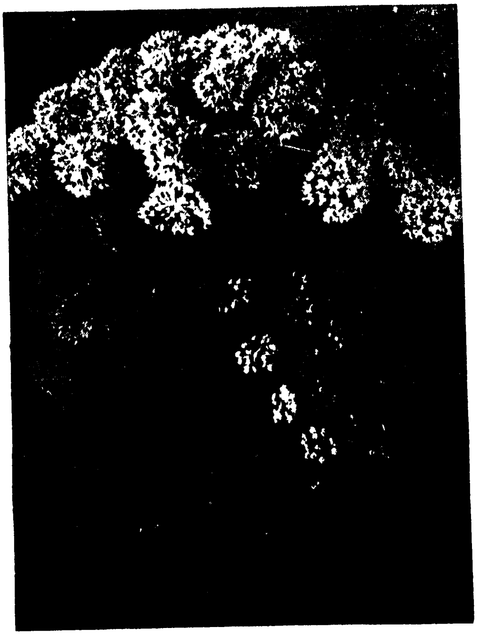
Certain bogland plants are found principally on the shores and cliffs of northern United States and Canada. Among them is the bird's-eye primrose with foliage besprinkled with sulphur-like meal.

The Marsh Cinquefoil

The marsh cinquefoil belongs to the rose family. It is a stout plant about a foot high with large purplish brown flowers. It is common in European bogs and in northern United States and Canada.

The Marsh Pennywort

This plant is also called the white-rot. Its round, smooth, shining leaves are the most conspicuous part of it, and the flowers, which are small, never rise above the leaves, and so are hard to find.



The Wild Angelica

The flowers of the wild angelica, white tinged with pink, are a familiar sight in European swamps. The plant is tall and makes a good yellow dye. We have about twenty species of angelica here.

Close by one will often find the delicate American Meadow-sweet, one of the spiræas, quite a large bush, with slender branches bent down by the pointed, open clusters of bloom at their ends. The florets are flesh-tinted in the bud, growing paler as they open, and are like miniature apple blossoms. The bush may easily be transplanted to a damp spot in the garden, and will flourish wonderfully.

THE CHOKEBERRY IS A RELATIVE OF THE SPIRÆA

Another shrub, closely related to the spiræa, and with white tiny apple-like flowers, but arranged in flat clusters, is the Chokeberry, that has small oval or obovate leaves sharply saw-toothed on the edges. It grows knee- or even waist-high, and often stands in water in woods or bogs. Late in summer the little bushes are loaded with red or nearly black berries, juicy and insipid, not larger than a pea, and either pear-shaped or globular.

THE QUAINT FLOWERS OF THE TURTLEHEAD

The edges of a marsh often seem to have sheets of dull white laid over them, due to crowds of the quaint Turtleheads. The slender stems, bearing pairs of glossy leaves, are topped by thickly crowded, odd-shaped blossoms, quite plainly suggesting in their shape the pointed jaw of a turtle, and also resembling a snapdragon, to which they are closely allied. But instead of being black and wrinkled, or brilliantly tinted, the floral turtleheads are of the texture and bluish whiteness of china; only about the woolly mouths are the flowers faintly touched with rosy purple.

THE BRIGHT BLUE BLOSSOMS OF THE FRINGED GENTIAN

They bloom rather late, but perhaps the loveliest of all the autumnal flowers are the Fringed Gentians. One is not always certain to find them in the same place year after year, for they seem to change from one wet meadow to another, but they are worth hunting for, and often grow in large colonies. The whole plant is glossy, with smooth narrow leaves, and the branches stand straight up and close together, bearing dozens of the bright blue blossoms. The buds are almost square, the four petals being twisted into a cone on top, but when they open in the sunshine, the lids of the box, as it were, flare widely, edged with most exquisite fringes. They are cautious flowers, and at the touch of night's cool fingers twist up their petals again, thus protecting the delicate stamens and pistil, at the bottom of the box, against frost. The sun, next day, causes them to open again, and they will do this several times before they wither away. The fringed gentian is very closely allied to the gentians of the Alps that bloom near the everlasting snows, and also to one of the curious plants of our swamps, the closed gentian—another glossy plant, with closed blue flowers clustered about the stem—flowers that always look like buds, as there is only a tiny aperture at the top of the tubular blossom.

THE GRASS OF PARNASSUS GROWS IN BOGS

The Grass of Parnassus is another beautiful bog flower, a member of the Saxifrage Family. Its leaves are oval, with pointed tip and heart-shaped base. They spring in a circle from the rootstock, and stand almost erect on long stalks.

The flower-stem is much longer than the leaves, and bears one flower at its summit. This is about an inch across, the five white petals being of rather thick substance and finely streaked with green. The large pistil is in the centre of the flower, and around it are five stamens. A fringe of imperfect stamens surrounds the green pistil like a trellis, and in climbing over this the bee or fly is apt to leave some pollen behind.

The European flower of this name, fabled to have grown up on Mount Parnassus, is at home here only in the Canadian border provinces and northward.

THE SPIRALLY TWISTED LADIES' TRESSES

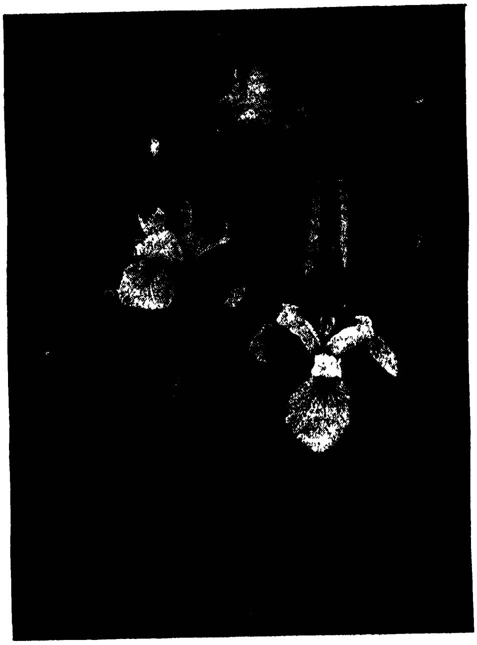
A swamp, especially a mossy cranberry bog, is just the place to look for many of our orchids, but the Ladies' Tresses are generally content with damp meadows, or even dry pastures. There is one common variety, however, known without much reason as the Nodding Ladies' Tresses, which is found in very wet soil, in marshes, or even in running water. A form of it, blooming in October, is very tall and strong-scented, and has cream-colored buds. Its flowers have a frosted appearance and are so arranged that the spike of flowers looks square in outline.

THE BIRD'S-EYE PRIMROSE COMMON TO EUROPE AND AMERICA

On the cliffs and shores of Maine and Quebec, and as far west as Michigan and

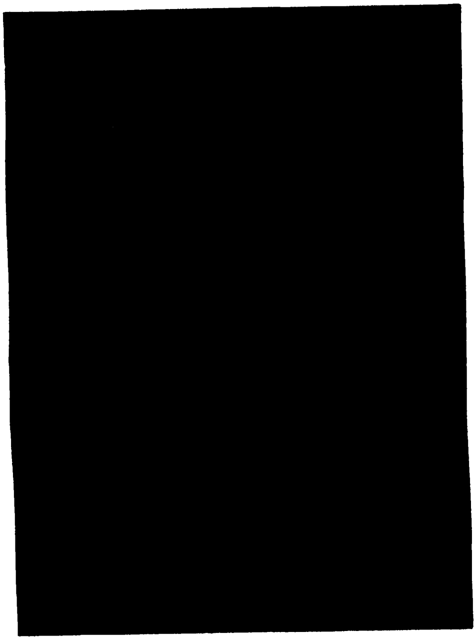
The Bog-myrtle

The sweet gale, or bog-myrtle, is a bushy plant that flowers before it is in leaf. The bitter leaves were once used in place of hops, and scent clothes.



The Swamp Iris

The swamp iris (versicolor) transforms our wet lands in springtime with its strikingly beautiful blue spikes.



The Ladies' Tresses

This exquisite spire of blossoms, that seem braided together, holds its head above the green grass of meadows in late summer, and is almost the loveliest of American orchids. Its flowers appear frosted.

The Common Cotton-grass

In the boggy districts here and there we often see what appear to be tufts of white cotton covering the ground. This is cotton-grass. Attempts made to spin it have failed, but it is used for stuffing pillows.

Minnesota, there is a pretty little primrose called the Bird's-eye Primrose, or Mealy Primrose, whose leaves are covered on the under-sides with a white or pale yellow powder.

The whole plant looks much more like the garden auricula than the common primrose of the woods, for its lilac or pale purple flowers are clustered, like those of the cowslip, at the top of a short stalk, a few inches above the unwrinkled leaves. It flowers in June and July, and gets its name of bird's-eye from a patch of yellow which is found around the mouth of the corolla-tube.

THE PURPLE-BROWN MARSH CINQUEFOIL

A purple-flowered relative of the common silverweed and barren strawberry grows in bogs in the northern United States and Canada. It is known as the Marsh Cinquefoil. It has a long woody root, like the yellow-flowered cinquefoil of the meadow, and, like it also, has its leaves divided into five or seven leaflets.

The rather pretty flowers are magenta-purple within and palish purple without, because of the green sepals which are longer than the petals. This flower can be found in wet places during June, July and August in the New England states and west to California. In the Middle Ages it was believed that the flower had power to cure various ills.

THE DARK GREEN LEAVES OF THE MARSH PENNYWORT

On the bog-moss we shall find a number of round dark green leaves from half an inch to two inches across, but with no stalk visible. If we pull one up, we shall see the reason for this. The stalk is there, but fixed in the middle of the leaf underneath. This is the Marsh Pennywort.

There is a slender stem which creeps through the moss, and, as it is hidden from the light, it is white. In the summer-time we may find its tiny cluster of pinkish green flowers. It is one of the Umbel-bearing Family, but it does not look as though it were related in the least degree to the cow-parsnip.

THE PIPE-LIKE STEM OF THE ANGELICA

Another umbel-bearer that we may find on the borders of the bog, as well as in damp places in woods, is the Wild Angelica, which we shall have no trouble at all in placing in its proper family.

It grows to a height of five or six feet, with a thick, jointed pipe-like stem, often of a purple tint. Its large wedge-shaped leaves are often a couple of feet in length, much divided, as are the leaves of most plants of this family. The umbels of white or purplish flowers are very large.

THE RED BERRIES OF THE CRANBERRY

In some parts of the country we shall find the Cranberry, a relative of the bilberry and cowberry. The evergreen leaves and the flowers are very similar, but the stems creep, the flowers are pale pink in color, and the berries are dark red and extremely acid to the taste. We may read more about these on page 2068.

THE FRAGRANT SWAMP MILKWEED KNOWN BY ITS MILKY FLUID

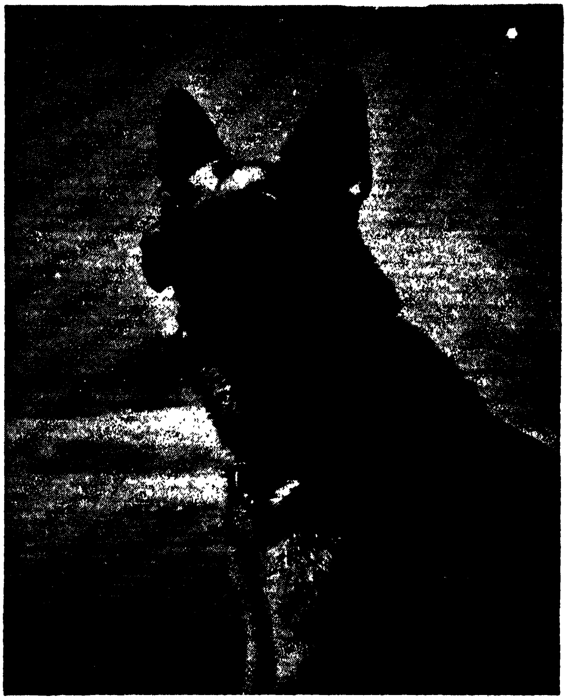
There are a number of Milkweeds, plants so called, as one can readily see, from the milk-white and very sticky juice that runs out of the leaves and stalks when bruised. They have small flowers, each of which is very unusual and curious in its appearance, gathered in umbels, as the clusters are called when the stalks all start from one spot, just as the ribs of an umbrella all spring from a tiny circle. Some of the umbels droop like great tassels, while others are stiffer and more upright. The Swamp Milkweed bears umbels of this latter kind, and is one of the prettiest of all. Its flowers are purple-pink and fragrant, and its very leafy stems are two or three feet high with narrowly oblong pointed leaves. In its tough stems is a grayish fibre so strong that it might be used like hemp, for ropes.

THE GORGEOUS FLOWERS OF THE SALT MARSHES

In late summer, marshes, especially salt marshes, glow with countless yellow composites, such as sunflowers and beggar-ticks, often woven together by strands of the climbing boneset, burdened by bunches of pale pink flowers, or by the viciously armed "tear-thumb." Deeper in the marsh are white-flowered arrowheads with their quaint triangular long-tailed leaves, the blazing velvety spikes of cardinal-flowers and the flaunting swamp-rose-mallow, whose great bell-shaped flowers, rose-colored and stained within with a deeper tint, show their near relationship to the hollyhock. There, too, is the rich deep purple ironweed, its many flower-heads all glowing against a background of green cat-tails.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 5871.

DOGS THAT HAVE DONE THEIR BIT



Courtesy, U. S. Marine Corps

IS there a child anywhere in the wide world who does not love a good dog? Perhaps some of you have heard about Balto, that remarkable "husky" (the name for dog in the Eskimo language) whose bravery saved many lives.

There have been books and verses written about dogs and pictures painted of dogs, but very seldom has there been a statue raised to a dog. The dog Balto has had a monument erected to the memory of his faithful courage and his magnificent strength, in Central Park, New York City. And what did he do?

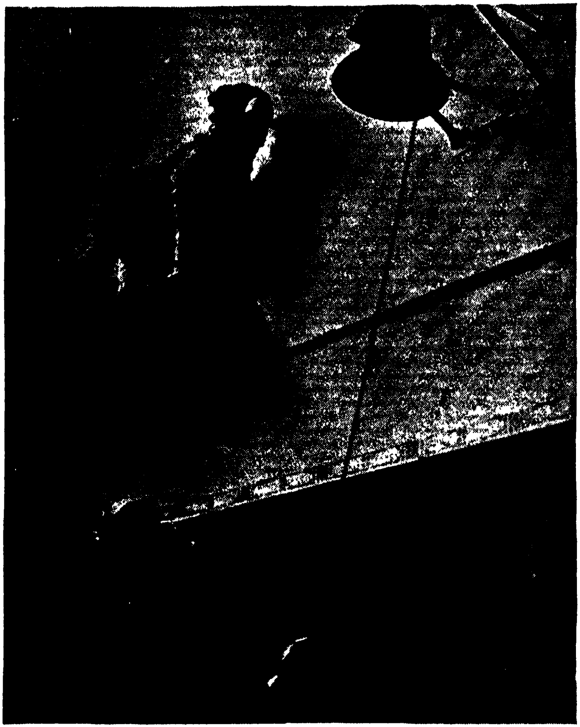
In the middle of winter, the far-off city of Nome, Alaska, was visited with a terrible sickness, which only one remedy could check. There was only a little of this medicine in Nome. At Nenana, 650 miles away, there was a supply of the serum; but the only way to carry it over those hundreds of miles was by runner and dog-team. So it was rushed forward by relay as fast as human endurance and "dog endurance" could carry it.

On the next-to-last lap of this desperate relay race, Kasson, the driver, ran into a blizzard, and never met the team that waited to relieve him. The thermometer stood at 30 degrees below zero, with a blinding gale blowing from the northwest. Kasson could no longer see his dogs or the trail; but Balto, the great Siberian, knew the trail and kept it, from Bluff into Nome—fifty-three miles. Kasson said: "I gave Balto, my lead dog, his head and trusted to him. He never once faltered. The credit is his."

For Balto it was just another entry to be made on his long record as a veteran of the Arctic trails. He started his career in 1915, when he led the Kasson team to victory in the Moose race, and again gained fame when he took Roald Amundsen, the explorer, north from Nome, at the time that the explorer planned his airplane flight across the Pole. He cut the record time from Nenana to Nome from nine days to five and a half days.

The story of Bob is the story of a dog who loved his master better than his own life. Bob was born in the year 1859 on board a ship bound to England from the Indies. When he was a year old he accompanied his master on board the Manchester, a vessel sailing for the United States. The Manchester, overtaken by storm, was shipwrecked within a few miles of shore, and it was only due to Bob's ability as a swimmer that his master was enabled to gain a rock which jutted up out of the water and afforded the pair temporary safety. Night came on, the tide rose, and still the fierceness of the storm made it impossible for man and dog to reach the shore. The dog's master, realizing the situation, decided to stake all on Bob's intelligence and faithfulness. He pointed out the distant shore, and motioned for the dog to take off.

Bob sprang into the turbulent waves, and



Swiss Federal Railroads

This ancient monument at the St. Bernard Hospice in Switzerland does honor to Barry, a wonderful dog who saved the lives of forty lost travelers in the snowy Swiss Alps.

after a stiff battle reached the shore. He found his way to a farmhouse, roused the inmates—for it was now late at night—and led them to the shore, where they could hear his master's cry for help. The storm was still raging, and it was impossible to attempt a rescue by means of a boat. A rope was fastened to Bob's neck. The dog needed no telling what to do next. Plunging into the water, he began the return trip to the rock. Time and again he almost drowned. Grit and endurance won, however, and he reached the rocky ledge just as the tide had begun to creep over it.

A few months later Bob's master embarked upon a second sea voyage and was again shipwrecked. This time the dog's brave and heroic efforts to rescue him were unsuccessful. The man was drowned, and Bob himself, after hours spent in the water, was picked up exhausted by fishermen. Later he ran away, boarded a ship bound for Liverpool, and immediately upon arriving in England traveled to London in the vain hope of finding his master.

Bob reached the familiar house near dusk, but a closed door and silence greeted him. Sorrowfully he lay down, and for more than twenty-four hours remained on guard before the entrance to his old home. The next night he became restless and, drawn probably by the smell of the water, wandered down to the river Thames.

At the moment of his arrival a blind man, being led by a small dog on a string, was walking along the bank near the edge. His tiny guide, realizing the danger, endeavored to pull him to safety, but the cord slipped through the man's fingers and with a cry he toppled over into the river. Bob flew to the rescue and soon had him safe on shore.

Bob must have decided that his services were needed about the river, for he stayed and became a self-appointed lifesaver. Within a short

Loew's Theatres

The dog Balto with his master. They checked epidemic in Nome, Alaska, by carrying serum through fierce cold and blizzard.

time he had saved the life of one child, a woman, and a young man who had been robbed and thrown into the water by thieves. By this time he was well known about the Thames, and officers of the Humane Society, discovering that he was homeless, adopted him and made him a member of the society, at the same time awarding him a medal for conspicuous bravery. Later, he was awarded the gold medal of honor for other heroic deeds, one of which was the rescue of a baby who had been forgotten in a burning building.

The story of Barry is a glorious one and a sad one. Barry was a wonderful St. Bernard dog who in ten years of heroic service saved the lives of forty travelers, lost in the mountain snows of the Swiss Alps.

One of Barry's most famous rescues was that of a ten-year-old child. Barry found the child lying in the snow already in the fatal slumber which precedes death by freezing. He warmed the child with his breath, and then proceeded to lick its hands and face in an attempt to rouse it to consciousness. This was finally accomplished, and when the child opened his eyes Barry lay down by him, and in the language of movement and expression, managed to make the child understand that he wished him to climb to his back. The little lost boy accepted the invitation, and was brought in safety to the hospice.

A monument to the memory of this splendid dog may be seen standing close to the St. Bernard Hospice, where monks take care of travelers who come to them on their way through the pass between Switzerland and Italy. Barry was killed by some unknown person who must have thought he was about to be attacked instead of rescued.

Stief was a German war dog. His master, a young German lieutenant in World War I, was ordered to lead an attack in an extremely dangerous position. The officer was wounded and fell down in the muck of the battlefield to die. The fire was so deadly that no one dared face it to attempt a rescue. Stief, however, sensing that his master was in trouble, gnawed through his leash and

U S Army Signal Corps

During World War II the United States Army and Navy trained thousands of alert and intelligent dogs for war duty. Here they are shown being "weighed in" and examined before beginning their training as recruits.

dashed across the bullet-swept field to where the officer lay. Securing a firm grip on the man's clothing, Stief commenced to drag him in, foot by foot. Only once did the dog release his hold for so much as an instant, and that was when a bullet creased him from shoulder to flank. The dog simply took a fresh hold and finished his job at the edge of the trench.

This is only one of many noble deeds which have been performed by courageous and faithful dogs whose loyalty to some beautiful dog ideal has won for them the honored title of "the best friend of man." Stief was given the Iron Cross.

Here is another story from World War I, an American story. The bugles blared at daybreak one morning at the army post, the colors were run up, and the officer of the day called the names of the guard at reveille on the parade ground. "Sergeant Casey," he called. No answer. Again he pronounced the name. Still no answer. There was a restless movement in the ranks, and the officer, himself amazed, directed that the sergeant's name go into the guard book as A.W.O.L. (absent without leave).

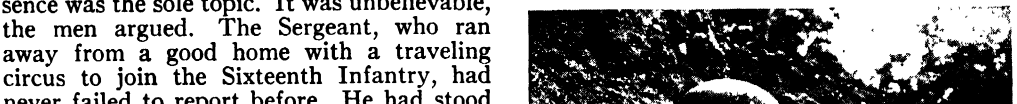
When the ranks broke, the Sergeant's absence was the sole topic. It was unbelievable, the men argued. The Sergeant, who ran away from a good home with a traveling circus to join the Sixteenth Infantry, had never failed to report before. He had stood every call and every parade since he joined the regiment. He was never in the orderly room, except on business, and he had never been seen to take a drink stronger than water. Gloom enwrapped the regiment, from Colonel F. H. Ford down. Sergeant Casey's perfect record was sullied.

Casey was pictured as vagabonding in forbidden places. Then the mail orderly, a particular chum of the Sergeant, thought to look in Casey's tent. Casey was lying there—he was dead. Dead—he who, ordered to remain behind when the Sixteenth went to France, was the first down the gangplank at St. Nazaire. The news flashed through the regiment. All were sad at first, but then came the comforting thought that the Sergeant's record at reveille had been unsullied.

The entire regiment, led by the colonel, turned out to honor the memory of the Sergeant. Even the "mule skinners" were in the procession that marched with slow steps behind the creaking caisson bearing the body, wrapped in his country's flag.

The procession halted at the cemetery, a neat mound took form and as taps died away the headpiece was put in place. "Sergeant Casey," it read, "Sixteenth Infantry, U. S. A.," and then: "He was only a dog, but he did his bit."

THE NEXT STORY OF GOLDEN DEEDS IS ON PAGE 6137.



U. S. Marine Corps

Two beautiful "devil dog" marines. At the left, Adonis of Dean examines his service record. At the right is Andy, with his partner; Andy's job was to discover enemy positions and to be on the alert for surprise attacks.

What Is a Folk Song?

Illustrated by Thomas Hart Benton

In every long settled country there are songs and melodies that have been handed down from one generation to the next, sometimes for hundreds of years. Until recent times such music was seldom written down. People learned the tunes and words by hearing others sing them or play them on simple musical instruments, and as time went on little changes came about in the words and the notes. Because these songs were not written down and copyrighted and printed, as most music is in our time, it is very seldom that the name of the original composer is known. This hardly matters, however, for most of this music has been so changed by the many people who have played and sung it that the man who made up such a song—perhaps a strolling minstrel, or a craftsman singing at his work—would never recognize it now. That is why such music is called folk music, for it is really the creation of the folk who have shaped and modified it as it was handed down, from father to son and from mother to daughter, usually in remote country districts where there was little distraction and people made their own entertainment.

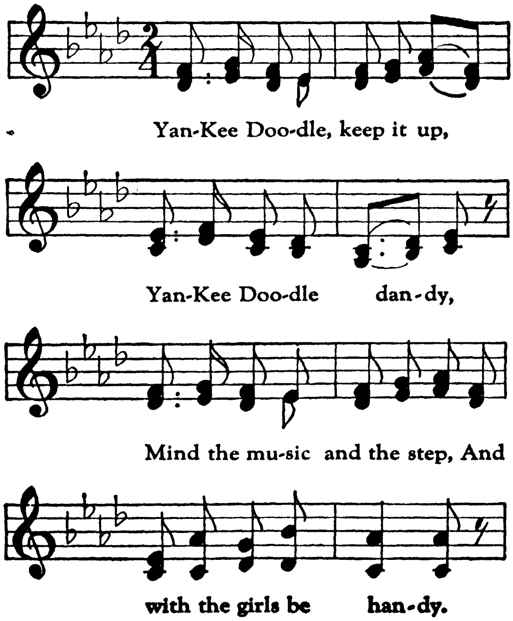
When the early settlers came to America they brought many of their songs with them. Today the old folk music still lingers in isolated spots, quiet backwaters in the rushing stream of American life. In the Appalachian Mountains, from Maine to Georgia, students of folk music have found the people singing many of these old songs, sometimes in the versions known in the Old World, and sometimes changed in accordance with the knowledge and taste of the mountain people. One of the most famous of these old ballads, Barbara Allen, can be heard with a great many variations.

In Quebec one still hears the songs that were brought over by the French settlers hundreds of years ago, and in Nova Scotia, Ontario and many other parts of the United States and Canada there are many old Scottish and Irish songs. In our own time new folk songs are still being developed and old ones revived.

What do the makers of folk music sing about? From the earliest times down to our own day, people have liked stories set to music. Stories of heroes, of lovers, of battles, shipwrecks, train wrecks and adventures of all kinds. This is the raw material of which folk songs have been made and are being made. Then there are religious songs, such as the Negro spirituals, and work songs, such as the chanties sung by sailors on the old-time sailing ships to give the right timing as they hauled on the ropes. The cowboys in the Old West sang as they circled the herds at night, and the river-boatmen sang at their work. Sometimes songs by known authors have come to be looked upon as folk songs.

We have selected a number of such songs for this chapter, and you will find other, more ancient folk songs, in the chapter on Story Songs and Ballads.

Yankee Doodle


Yan-Kee Doo-dle, keep it up,
Yan-Kee Doo-dle dan-dy,
Mind the mu-sic and the step, And
with the girls be han-dy.

Yankee Doodle

FATHER and I went down to camp,
Along with Captain Goodin',
And there we saw the men and boys,
As thick as hasty puddin'.

Yankee Doodle, keep it up,
Yankee Doodle dandy,
Mind the music and the step,
And with the girls be handy.

And every time they shoot it off,
It takes a horn of powder,
And makes a noise like father's gun,
Only a nation louder.

And there was Captain Washington,
And gentlefolks about him,
They say he's grown so tarnal proud
He will not ride without 'em.

And there we see a thousand men,
As rich as Squire David;
And what they wasted every day,
I wish it could be savèd.

The 'lasses they eat every day,
Would keep a house in winter;
They have so much that, I'll be bound,
They eat when they've a mind to.

And there I see a swamping gun,
Large as a log of maple,
Upon a mighty little cart;
A load for father's cattle.

He had got on his meeting clothes,
And rode a strapping stallion,
And gave his orders to the men,—
There must have been a million.

The troopers, they would gallop up,
And fire right in our faces;
It scared me almost half to death
To see them run such races.

It scared me so I hoofed it off,
Nor stopped, as I remember,
Nor turned about till I got home,
Locked up in mother's chamber.

Swing Low Sweet Chariot

SWING low, sweet chariot,
Comin' for to carry me home.
O swing low, sweet chariot,
Comin' for to carry me home.
Swing low, sweet chariot,
Comin' for to carry me home.

I looked over Jordan, and what did I see
Comin' for to carry me home;
A band of angels comin' for me,
Comin' for to carry me home.

If you get there before I do,
Comin' for to carry me home;
Tell all my friends I'm comin' too,
Comin' for to carry me home.

Swing low, sweet chariot,
Comin' for to carry me home.
Swing low, sweet chariot,
Comin' for to carry me home.

Reuben Ranzo

OH, poor old Reuben Ranzo,
Ranzo, boys, Ranzo;
Oh, poor old Reuben Ranzo,
Ranzo, boys, Ranzo.

Oh, Reuben was a tailor,
Ranzo, boys, Ranzo;
He shipped on board a whaler,
Ranzo, boys, Ranzo.

But he could not do his duty,
Ranzo, boys, Ranzo,
No, he could not do his duty,
Ranzo, boys, Ranzo.

And they gave him nine and thirty,
Ranzo, boys, Ranzo,
Yes, lashes nine and thirty,
Ranzo, boys, Ranzo.

Now, the captain was a good man,
Ranzo, boys, Ranzo,
He took him in the cabin,
Ranzo, boys, Ranzo.

And he gave him wine and water,
Ranzo, boys, Ranzo,
Rube kissed the captain's daughter,
Ranzo, boys, Ranzo.

He taught him navigation,
Ranzo, boys, Ranzo,
To fit him for his station,
Ranzo, boys, Ranzo.

Now, Ranzo he's a sailor,
Ranzo, boys, Ranzo,
He's chief mate of that whaler,
Ranzo, boys, Ranzo.

He's married the captain's daughter,
Ranzo, boys, Ranzo,
And sails no more on the water,
Ranzo, boys, Ranzo.

Bury Me Not on the Lone Prairie

"O BURY me not on the lone prairie,"
These words came slowly and
mournfully
From the pallid lips of a youth who lay
On his cold damp bed at the close of day.

"O bury me not on the lone prairie
Where the wild coyote will howl o'er me,
Where the cold wind weeps and the grasses
wave;
No sunbeams rest on a prairie grave."

He has wasted and pined till o'er his brow
Death's shades are slowly gathering now;
He thought of his home with his loved
ones nigh,
As the cowboys gathered to see him die.

Again he listened to well known words,
To the wind's soft sigh and the song of birds;
He thought of his home and his native bowers,
Where he loved to roam in his childhood
hours.

"I've ever wished that when I died,
My grave might be on the old hillside,
Let there the place of my last rest be—
O bury me not on the lone prairie!

"O'er my slumbers a mother's prayer
And a sister's tears will be mingled there;
For 'tis sad to know the heart-throb's o'er,
And that its fountain will gush no more.

"In my dreams I say"—but his voice failed
there;
And they gave no heed to his dying prayer;
In a narrow grave six feet by three,
They buried him there on the lone prairie.

May the light winged butterfly pause to rest
O'er him who sleeps on the prairie's crest;
May the Texas rose in the breezes wave
O'er him who sleeps in a prairie grave.

And the cowboys now as they roam the plain,
(For they marked the spot where his bones
have lain)
Fling a handful of roses over his grave,
With a prayer to Him who his soul will save.

A Cowpuncher's Song

As I walked out one morning for pleasure,
I spied a cowpuncher a-riding along;
His hat was throwed back and his spurs was a-jingling,
As he came toward me a-singing' this song.

Whoopee ti yi yo, git along little dogies,
It's your misfortune, and none of my own,
Whoopee ti yi yo, git along little dogies,
For you know Wyoming will be your new home.

Early in the spring we round up the dogies,
Mark and brand and bob off their tails;
Round up our horses, load up the chuck-wagon,
Then throw the dogies upon the trail.

It's whooping and yelling and driving the dogies;
Oh, how I wish you would go on;
It's whooping and punching and go on little dogies,
For you know Wyoming will be your new home.

Some boys goes up the trail for pleasure,
But that's where you get it most awfully wrong;
For you haven't any idea the trouble they gave us
While we go driving them along.

When the night comes on and we hold them on the bedground,
These little dogies that roll on so slow;
Roll up the herd and cut out the strays,
And roll the little dogies that never rolled before.

Your mother she was raised way down in Texas,
Where the jimson weed and the sand-burrs grow;
Now we'll fill you up on prickly pear and cholla
Till you are ready for the trail to Idaho.

Oh you'll be soup for Uncle Sam's Injuns;
"It's beef, heap beef," I hear them cry.
Git along, git along, git along little dogies,
You're going to be beef steers by and by.

Joshua Fit De Battle of Jericho

This is one of the most popular of the religious folk songs of the American Negroes. Unlike many of the spirituals, it is not mournful, but is a joyous, prideful way of telling the story of the fall of Jericho.

JOSHUA fit de battle of Jericho,
Jericho, Jericho,
Joshua fit de battle of Jericho,
And de walls come tumbling down.

You may talk about yo' king of Gideon
Talk about yo' man of Saul,
Dere's none like good old Joshua
At de battle of Jericho.

Up to de walls of Jericho,
He marched with spear in hand;
"Go blow dem ram horns," Joshua cried,
"Kase de battle am in my hand."

Den de lamb ram sheep-horns begin to blow,
Trumpets begin to sound,
Joshua commanded de chillun to shout,
And de walls come tumbling down.

Dat morning,
Joshua fit de battle of Jericho,
Jericho, Jericho,
Joshua fit de battle of Jericho,
And de walls come tumbling down.

Villikins and His Dinah

AN OLD LONDON STREET SONG

OH! 'tis of a rich merchant,
In London did dwell,
He had but one daughter,
An uncommon nice young gal!
Her name it was Dinah,
Scarce sixteen years old,
She had a large fortune
In silver and gold.

As Dinah vas valking
In the garden vun day,

(It was the front garden, not the back garden.)

Her papa came up to her,
And thus he did say,
Go, dress yourself, Dinah,
In gor-ge-ous array
And I'll get you a husband,
Both val-ly-ant and gay.

(This is what the infant progeny said to the author of her being.)

Oh, papa! oh, papa!
I've not made up my mind,
To marry just yet
I do not feel inclined,
And all my large fortune,
I'll freely give o'er,
If you'll let me stay single
A year or two more.

This is what the indignant parient replied—I represent the father.

Then go, boldest daughter,
The parient replied,
If you don't consent to be
This here young man's bride,
I'll leave your large fortune
To the nearest of kin,
And you shan't have the benefit
Of one single pin.

Now comes the epiflabbergastrinum of the lovier.

As Villikins vas valking
The garden around—
(The aforesaid front garden,)
He spied his dear Dinah
Lying dead on the ground,
A cup of cold pison
It laid by her side,
And a billy dux stating
By pison she died.
Taken inwardly.

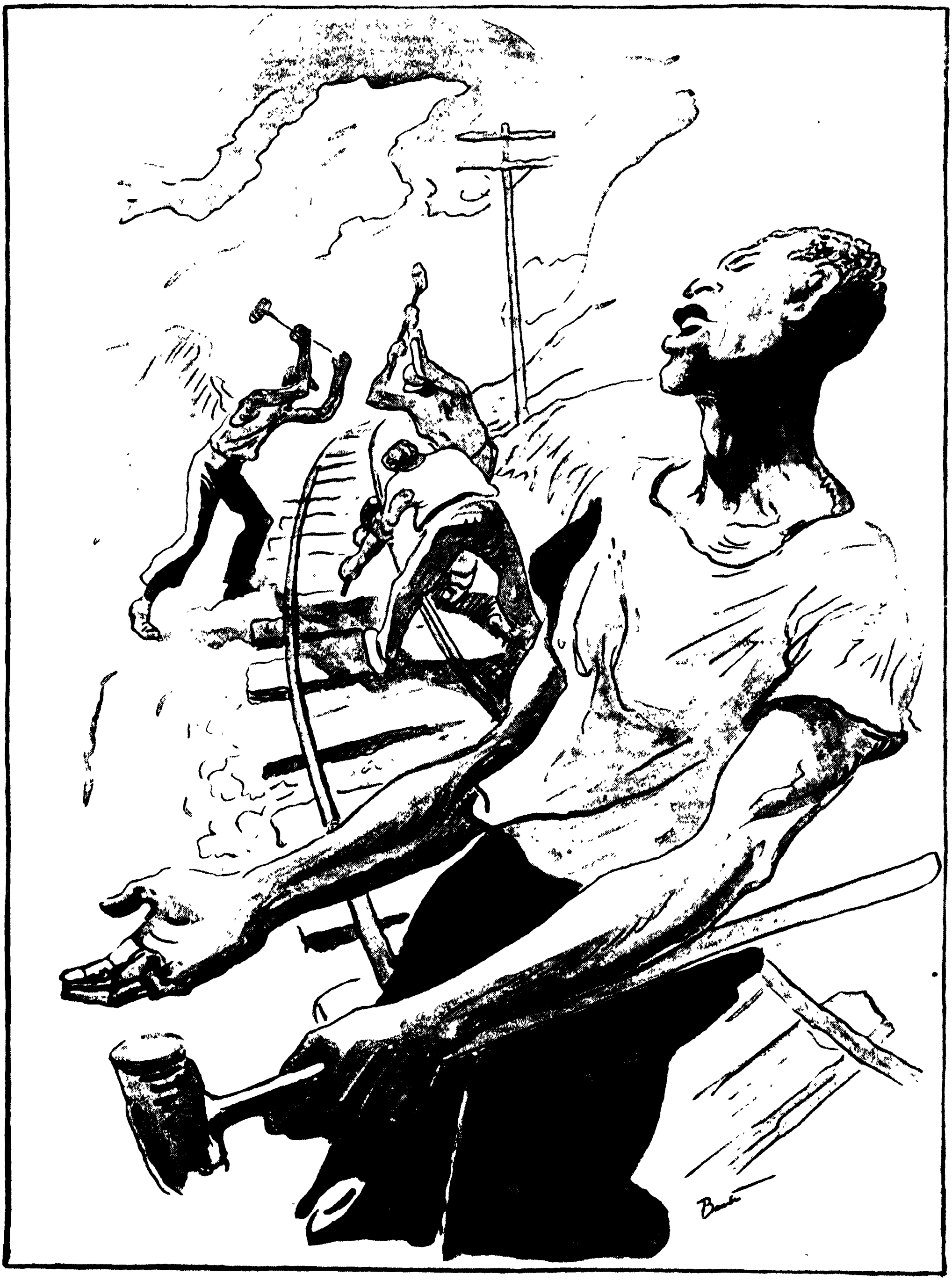
This is what the lovier did.

He kissed her cold corpus
A thousand times o'er,
He called her his Dinah—
Though she was no more!
He drank the cold pison
Like a true lovier brave,
And now Villikins and his Dinah
Lie a-buried in one grave.
Both on 'em.

MORAL

Now all you young vimmen,
I bid you beware,
And never by any means
Disobey the guv'ner:
And all you young fellers,
Mind who you clap eyes on,
Think on Villikins and Dinah
And the cup of cold pison.
Taken inwardly.

MEN WHO SING WHILE THEY WORK



Many folk songs have originated among people working at long or tedious jobs. The men who built our railroads and dug our canals made up or adapted many songs to give rhythm to their work and to lighten their spirits.

Workin' on the Railroad

I BEEN workin' on the railroad
All the livelong day;
I been workin' on the railroad
Just to pass the time away.

Can't you hear the whistle blowing,
Rise up so early in the morn;
Can't you hear the Captain calling,
"Dinah, blow your horn!"

Dinah, won't you blow,
Dinah, won't you blow,
Dinah, won't you blow,
Your horn, your horn
Dinah, won't you blow,
Dinah, won't you blow,
Dinah, won't you blow
Your horn!

Someone's in the kitchen with Dinah,
Someone's in the kitchen I know,
Someone's in the kitchen with Dinah,
Strummin' on the old banjo!

Fe, fi, fiddlety-I-ay, fe, fi, fiddlety-o!
Fe, fi, fiddlety-I-ay,
Strummin' on the old banjo!

Water-Boy

In this famous song the prisoner, breaking rock on the county roads, calls to the water-boy to quench his thirst, boasts of his skill at rock-breaking, and reflects on the gambling that has caused his downfall.

WATER-BOY, where are yo' hidin'?
If yo' don't-a come, I'm gwineter tell-a yo' mammy.

Dere ain't no hammer dat's on-a dis mountain,
Dat ring-a like mine, boys, dat ring-a like mine.
Done bus' dis rock, boys, f'om heah to Macon,
All de way to de jail, boys, yes, back to de jail.

Yo' Jack-o'-Di'monds, yo' Jack-o'-Di'monds,
I know yo' of old, boys, yas, I know yo' of old.
Yo' robbed my pocket, yas, robba my pocket,
Done robba my pocket, of silver an' gold.

Water-Boy, where are yo' hidin'?
If you' don't-a come, I'm gwineter tell-a yo' mammy.
Oh, Water-Boy!

Widdecombe Fair

This folk song, which dates from the eighteenth century, has come to be the special song of Devonshire in England. Widdecombe, or Widecombe-on-the-Moor, is a village near the town of Ashburton in Devonshire.

TOM PEARSE, Tom Pearse, lend me your gray mare,"
All along, down along, out along, lee.
"For I want for to go to Widdecombe Fair,
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

"And when shall I see again my gray mare?"
All along, down along, out along, lee.
"By Friday soon, or Saturday noon,
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all.'
Old Uncle Tom Cobley and all.

Then Friday came and Saturday noon,
All along, down along, out along, lee.
But Tom Pearse's old mare hath not trotted home,
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

So Tom Pearse he got up to the top o' the hill,
All along, down along, out along, lee.
And he seed his old mare down a-making her will,
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

So Tom Pearse's old mare her took sick and her died,
All along, down along, out along, lee.
And Tom he sat down on a stone, and he cried
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

But this isn't the end o' this shocking affair,
All along, down along, out along, lee.
Nor, though they be dead, of the horrid career
Of Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

When the wind whistles cold on the moor of a night,
All along, down along, out along, lee.
Tom Pearse's old mare doth appear, gashly white,
Wi' Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

And all the long night be heard skirling and groans,
All along, down along, out along, lee.
From Tom Pearse's old mare in her rattling bones,
And from Bill Brewer, Jan Stewer, Peter Gurney, Peter Davy, Dan'l Whiddon, Harry Hawk,
Old Uncle Tom Cobley and all."
Old Uncle Tom Cobley and all.

The Lincolnshire Poacher

When I was bound apprentice in famous Lincolnshire,
Full well I served my master for more than seven year,
Till I took up to poaching—as you shall quickly hear:
Oh, 'tis my delight on a shiny night
In the season of the year!

As me and my comrade were setting of a snare,
Twas then we spied the gamekeeper, for him we did not care,
For we can wrestle and fight, my boys, and jump o'er anywhere:
Oh, 'tis my delight on a shiny night
In the season of the year!

As me and my comrade were setting four or five,
And taking on 'em up again we caught a hare alive,
We took the hare alive, my boys, and through the woods did steer:
Oh, 'tis my delight on a shiny night
In the season of the year!

I threw him on my shoulder, and then we trudgèd home,
We took him to a neighbor's house and sold him for a crown.
We sold him for a crown, my boys, and I did not tell you where:
Oh, 'tis my delight on a shiny night
In the season of the year!

Success to every gentleman that lives in Lincolnshire,
Success to every poacher that wants to sell a hare,
Bad luck to every gamekeeper that will not sell his deer:
Oh, 'tis my delight on a shiny night
In the season of the year!

Blow the Man Down

O blow the man down, bullies, blow the man down,
Way ay—blow the man down!
O blow the man down in Liverpool town.
Give me some time to blow the man down!

As I was walking down Paradise Street,
Way ay—blow the man down!
A Liverpool bobby I chanced for to meet,
Give me some time to blow the man down!

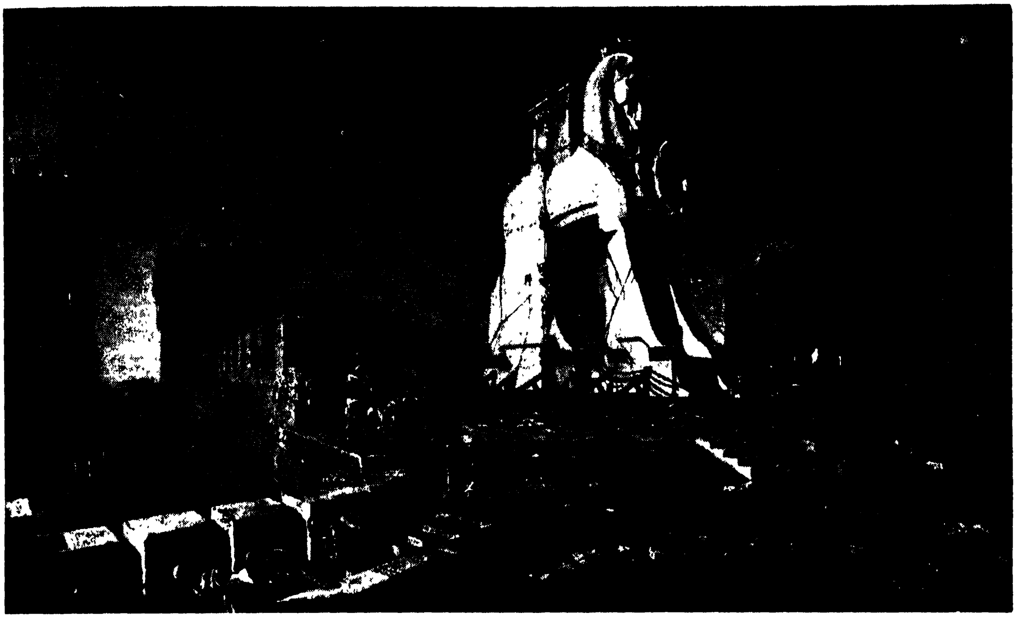
Says he, "You're a Blackballer by the cut of your hair,"
Way ay—blow the man down!
"I know you're a Blackballer by the clothes that you wear."
Give me some time to blow the man down!

"You've sailed in a packet that flies the Black Ball:"
Way ay—blow the man down!
"You've robbed some poor Dutchman of boots, clothes and all."
Give me some time to blow the man down!

"O policeman, policeman, you do me great wrong;"
Way ay—blow the man down!
"I'm a *Flying Fish* sailor just home from Hongkong!"
Give me some time to blow the man down!

They gave me six months in Liverpool town,
Way ay—blow the man down!
For kicking a policeman and blowing him down.
Give me some time to blow the man down!

THE NEXT WONDER QUESTIONS ARE ON PAGE 5839.
THE NEXT POEMS ARE ON PAGE 5822.



From the Permanent Collection of The Corcoran Gallery of Art
The Trojan Horse, ancient "secret weapon" described in Homer's epic about the fall of Troy—the Iliad.

The LITERATURE *of* GREECE

LISTEN to a child crooning to himself at play. Notice how a baby is lulled to sleep by a slumber-song—a pattern of sounds whose meaning it can not yet understand. It seems to have been true from the beginning of man's history that rhythmic sounds—the lapping of waves, verse and music—have charmed us. Certainly all early literatures have begun with simple word-tunes—lullabies, songs sung by shepherds to help pass the long, lonely days, religious chants or hymns. Later came praises of a hero, a king or warrior chief, and oftener than not the hero was said to have descended from a god or goddess. Most of the bits and scraps of very ancient literatures that we have today are of these kinds. Still later came stories of adventure on land and sea, stories of love and devotion, of crime and punishment, family trees, descriptions of palaces, ships, clothing and armor.

In every country, as hundreds of years passed, songs ran together, and were added to. Legends about heroes grew longer, and took on dignity and splendor. Some singers made singing their business. Bards, we call them. Bards were great travelers, and they carried their wares—their songs—with them. They had prodigious memories, and the longer the story was, the more welcome the story-teller.

In time a number of popular old songs and stories of a land would be grouped around a central character—a legendary hero, king or royal house, or a group of heroes.

That is the way Greek literature began, from hymns and songs and tales that were popular 3,500 years ago. One of the stories that grew great with the centuries was about a hero of Thessaly, Achilles, a mighty warrior who, with some other Greek chieftains, led an expedition against a rival kingdom in Asia Minor. A bard gifted with surpassing genius wrought them into a story that gave him immortal fame. The name by which we know this bard is Homer. Who he was or where he lived we do not know. He is himself now almost as legendary as the heroes about whom he sang. One legend is that Homer was a blind poet of Ionia, who wandered from city to city, reciting his tales, as after-dinner entertainer at banquets in the great houses. He lived perhaps in the tenth century B.C. He chanted his pieces, plucking at the strings of a cithara (a crude sort of harp). And so Homer is sometimes called "the blind harper." In the article Our Unwritten Literature we tell you more about Homer's work, and about similar collections of songs in many languages. Such collections, when brought together to make an important narrative, are called epics. Two of Homer's epics have come down to us: the ILIAD and the ODYSSEY.

LONGFELLOW USED HOMER'S VERSE PATTERN IN HIS EVANGELINE

The verse-pattern of Homer's epics was the dactyllic hexameter—six feet, each having one long and two short syllables. Longfellow used this pattern in EVANGELINE.

THIS is the FORest priMEVal,
The MURmuring PINES and the HEMlocks

Other bards, recognizing a master, copied Homer's arrangements of the old legends. No doubt later men improved upon them. Thus, the ILIAD and the ODYSSEY grew, until at last they were put into writing. All the world's culture is infinitely richer through having the ILIAD and the ODYSSEY. We give an account of the ILIAD on page 3076, and of the ODYSSEY on page 4337.

There were other epics of the Homeric period, of which only fragments have come down to us. We know much more about these than could be gleaned from the fragments, however. Greek critics and historians of the Golden Age knew and spoke of them; dramatists and other poets drew on them for themes.

THE PARODIES THAT MADE MEN LAUGH AT EPIC POEMS

An epic is a thing of dignity and grandeur, and such a work of art, unless it is well-nigh perfect, may become over-solemn and even ridiculous. In the centuries following Homer, men began to laugh at some of the pretentious pieces composed by less gifted poets; and some bards chanted parodies of epics. One such parody was THE BATTLE BETWEEN THE FROGS AND THE MICE. This has been called the beginning of Greek comedy.

The next great name in Greek literature is Hesiod, who lived, perhaps around 800 B.C., at the foot of Mount Helicon, in Boeotia. He was a farmer, no traveling bard. He composed poems because he felt he had something to say, not to entertain, nor to preserve the memory of the ancient glories.

His poems were wise sayings, cleverly expressed, observations on nature and on man. Some of the "old saws" of Benjamin Franklin in POOR RICHARD'S ALMANAC bear a close resemblance to the good advice handed out by Hesiod.

HESIOD STARTED A POEM BECAUSE HE LOST A LAWSUIT

The most important accomplishment of Hesiod was a long poem, WORKS AND DAYS. The inspiration for this is said to have been a lawsuit which Hesiod lost. Feeling himself bitterly wronged, he set out to give expression to his anger; but poetic ardor soon took hold. He forgot his anger, and became interested in the writing for its own sake. The poem is in three parts. The first part is called ON JUSTICE, and is concerned with the relations between gods and men, and between men and their fellows. "If all men labor and are good, we shall all be happy," the poet says.

The second part of the poem, ON WORKS, is the section for which Hesiod is famed. It is a series of descriptions of country life around the year—the planting, growing, harvesting and resting seasons; tools, livestock, clothing, food, farm help and kindred subjects. Here is a treasury of information on life in early Greece.

The third part of the poem, DAYS, is a calendar in verse, telling which days are favorable and which are unfavorable for certain ventures. There is considerable doubt as to whether Hesiod really wrote the calendar—it may have been added later. Hesiod was the author of other works, among them a poem about the gods, Theogony.

The poetry of Hesiod, instructive and religious, rather than entertaining, is called didactic. There was a long period in which didactic verse was popular. Many of the didactic poems were genealogies, that is, family trees of gods and heroes and great families. These served as reference works for many a later writer.

POEMS ACCOMPANIED BY THE LYRE WERE CALLED LYRICS

When the heroic epics and the didactic verse had had their day, there was a return to the shorter, simpler poems, verse composed to be sung, not chanted. Such poems usually express a mood or feeling—love, worship, grief, triumph, happiness, contentment and so on, hymns to the gods, praises to heroes. Generally these were sung to the cithara (which had four strings), the lyre (an instrument like the cithara, having seven strings) or the flute. The "tune" exactly fitted the words. Such poetry is to this day called lyric poetry; and the words of our popular songs are called the lyrics. Of course, much lyric poetry is written nowadays without music; but if it is a good lyric, such a poem is only waiting for the right composer to fit music to it. Shakespeare's charming lyric "Who is Sylvia?" waited almost two hundred years for Schubert's lovely tune.

TERPANDER OF LESBOS, THE ISLE DEDICATED TO LYRIC POETRY

The Greek lyric writers composed their own music. One of the masters of this form of verse was Terpander, who lived around the beginning of the seventh century B.C. He was born on the island of Lesbos, the isle to which the head of Orpheus was said to have been carried after his death. (Orpheus, you remember, was the mythical poet who played such divine music on the lyre that he charmed even the beasts.)

Two forms of the lyric were the elegy and the iamb. The elegy was, at first, a song to be accompanied by the elegos, a flute. The flute was the instrument used at funerals, and so funeral-songs came to be called elegies. Poems about death are still called elegies. Gray's ELEGY WRITTEN IN A COUNTRY CHURCHYARD is a famous one.

IAMBE, THE SERVANT AT ELEUSIS WHO MADE A GODDESS LAUGH

The iamb was named for Iambe, the first court fool known to legend. According to the old myth, Proserpine, daughter of the goddess Demeter, was snatched off to the underworld to be the wife of Pluto. The sorrowing mother sought her daughter everywhere. Not finding Proserpine, she gave way to grief. A serving woman, Iambe, who had a quick wit and a sympathetic heart, was able to make Demeter laugh. And so in time bright, witty poetry came to be called iambic. The foot, or measure, which it employed was also called iambic. This foot has a short, then a long syllable. It has bounce.

My LITtle HORSE must THINK it QUEER
To STOP withOUT a FARMhouse NEAR.

Only fragments of the elegiac and iambic poems of the early Greeks have come down to us. The great writers of elegies and iambs were Callinus of Ephesus, Archilochus of Paros and Simonides of Samos, all of whom probably lived at the same time as Terpander; and Tyrtaeus, whose legend is interesting. During the second Messenian War (685-668) the men of Sparta were getting the worst of it, so they asked the oracle at Delphi to help. The oracle advised them to send to Athens for a leader. This they did. There was never any love between Sparta and Athens. In answer to the request for a leader, the Athenians as a joke sent Tyrtaeus, a lame schoolmaster. Much to the surprise of Athens, Tyrtaeus, by his military poems, was able to inspire the Spartans with such courage that they won the war.

SOLON, THE WISE MAN WHO EVER KEPT HIS KNOWLEDGE GREEN

Other writers of elegies were Mimnerus of Colophon, sixth century; and Solon of Athens, who lived about 640 to 559 B.C. Solon was of noble birth, but poor. He engaged in trade, traveled widely and became rich. When he returned to Athens in 610, he found the city in a wretched condition. Its government was confused; great public debts had piled up, and there was little respect for law and order. Solon, though he was only thirty years old, undertook the forbidding task of rebuilding his beloved city. He did it, first by his inspiring songs, afterwards, when the citizens had put him in power, by wise government. He left us, among fragments of his verse, this line written in his last years: "I grow old learning daily some new fact."

SIMONIDES AND HIS EPITAPH TO THE SPARTAN HEROES

Theognis of Megara and Phocylides of Milesia, who lived in the latter half of the sixth century, wrote verse that was didactic in subject, though light in form. Simonides of Ceos wrote elegant epigrams in verse. One of the most famous is the distich (two-line verse) which he wrote to be inscribed on the tomb of the Spartan heroes who fell at Thermopylae:

Go, stranger, tell them at Sparta that here we lie.
Obedient to her laws.

There was a type of lyric poetry called melic, or melodious, full of melody. Elegies and iambs belonged to this type; so did other forms more closely bound to dancing. Following Terpander there were on the island of Lesbos, a number of melic poets who had astonishing genius. They developed a verse form which came to be called the Lesbian ode. Alcaeus and Sappho, a woman, were masters of this form. They lived at the same time and were rivals in verse-making. Each has left us only bits and scraps, and it is difficult to choose between them—Alcaeus with his grace and humor; Sappho a tender girl one minute, a sharp-tongued woman the next. Both Alcaeus and Sappho wrote a number of love poems. Sappho had a school where girls were taught the art of verse-making as well as the various womanly graces which would fit them to be worthy wives of important men.

THE HAPPY STYLE OF ANACREON WHICH POETS STILL LOVE TO IMITATE

Anacreon the Ionian also wrote odes in the Lesbian manner; and love was one of his favorite themes. He also liked to write about the joy of drinking. Here are a few words from a love-poem showing his delicate skill with words:

> "Eros, the god with the golden hair, hit me with a purple ball, and invited me to play with the young girl who wore the broidered sandals."

For centuries poets have had fun copying the happy style of Anacreon. Such imitations are called Anacreontics.

Thaletas and Alcman and Arion wrote ornate lyrics, songs fitted to choral dances. Stesichorus carried forward this art. He was a Greek born in Sicily, about the middle of the seventh century, B.C. His real name was Tisias. Because he wrote so many odes to be sung—and danced—by choruses, he came to be called Stesichorus, Arranger of the Chorus. His genius had an almost epic grandeur.

Simonides, of the choral lyric, was born on the isle of Ceos about 556 B.C. He came to Athens when he was something over thirty, where he met Anacreon and other literary men; he lived in Thessaly for a while, then returned in Athens, from where he made long journeys. In Sicily he met Pindar, his rival. The Persian Wars were fought during his lifetime; and Athens enjoyed her Golden Age. He was a part of the city's brilliant culture. His skill in verse-making was more than matched by his learning, his worldly wisdom and his warm heart. Simonides lived to the ripe old age of eighty-nine.

PINDAR, NOBLEST OF ALL THE GREEK LYRIC POETS

The greatest of all the lyric poets was Pindar, greatest in inspiration, imagination and power. The world is fortunate in having more than forty of his complete poems which have been preserved, and many fragments. Pindar was born near Thebes in 521 B.C., to an illustrious family. One day, so the legend goes, while the infant Pindar slept, some bees dropped honey (meli) on his lips, a token that he was to become a melic poet. Like all lyric poets, he was composer of music as well as writer of words. He wrote patriotic odes of great splendor, not only for Thebes but for Athens, too, during the Persian Wars. He knew the men at the top in government, art and finance, over the widespread Greek world. He died around 441 B.C. During his lifetime all men paid tribute to his genius, and today we revere him still.

Bacchylides, nephew of Simonides, was born on Ceos around 500 B.C. Like Pindar and Simonides he lived for a while at the court of Hiero, in Syracuse, and three of his odes were dedicated to this monarch. Bacchylides wrote choral lyrics of great beauty; about fourteen hundred lines have come down to us, bits of triumphal odes, paeans of praise, and other types.

CORINNA, THE WOMAN WHO BEAT PINDAR IN A POETRY CONTEST

Among the lesser lyric poets was a woman, Corinna of Thebes (or perhaps of Tanagra), a little older than Pindar. She is said to have taught him, and to have competed with him for a prize, and to have won it!

Like the poetry, the prose of Greece started just with religious writing and with historical accounts. Some of the early prose is known to every child in the Fables of Aesop the Slave. These moral fables had talking animals as characters. Aesop, the supposed writer, is almost as legendary a figure as Homer. Whether Aesop was really a slave, we do not know. He was said to have lived in the sixth century B.C. The fox that said "the grapes are sour", the boy who cried "Wolf!", the hare and the tortoise, the dog in the manger,—these, and many other Aesop characters, still live in our daily speech.

SCIENCE AND PHILOSOPHY WERE STUDIED AS ONE SUBJECT

In the article beginning on page 588 we tell you about some of the early Greek scientists. Most of these men were philosophers as well as scientists. Thales, Heraclitus, Pythagoras, Xenophanes, Empedocles, Leucippas, Anaxagoras, Anaximenes, Zeno, Epicurus and Anaximander all speculated on the nature of the world and man's nature. Some fragments of their writings have come down to us. Hippocrates, the "father of medicine is mentioned on page 2722.

When we think of Greek history writers

we think of three names—Herodotus, Thucydides and Xenophon. Herodotus, "father of history," was born at Halicarnassus in Asia Minor, about 484 B.C. His family was well-to-do, and Herodotus as a young man traveled extensively for pleasure. He was well educated, and had a quick, observing intelligence. He noted carefully many things about the lands he visited—how the people lived, how they dressed, their speech, religion, form of government, customs and history. Facts about the land itself he set down, for he realized that geography has an influence upon the course of events. He went south as far as Egypt, and to other parts of Northern Africa, and east beyond Babylon. He visited at the Hellespont and along the Euxine Sea, what we now call the Black Sea. He saw Syria, Palestine and many Mediterranean isles. The latter part of his life was spent in a Greek colony at Thurii, Italy, and there he wrote his HISTORY, in nine books.

THE HISTORY OF HERODOTUS WAS A "BEST SELLER"

This was the first Greek work of any size to be written in prose. The HISTORY is very much concerned with the Persian Wars, and carries the story of Greek and Persian conflicts back into legend, even into mythical times; yet much of the work is solidly based on facts. Herodotus was accused by Thucydides, a younger historian, of being too popular a writer. It is certainly true that Herodotus is fascinating to read even today for the pictures he paints of the world he knew, for the little stories he intertwined in the more technical account, and for the drama and suspense in his narrative. He was not a historian for other historians, but rather the gifted author of a "best seller." Herodotus died at Thurii, some say in 425 B.C., others put the date as late as 409 B.C.

THUCYDIDES, A CAREFUL HISTORIAN WITH A FLAWLESS PROSE STYLE

Thucydides (about 471-396 B.C.) was, and remains, a historian's historian. He was one of the glories of the Age of Pericles and Athens was his great love though he was exiled from her for a time. Thucydides was the historian of the Peloponnesian War, that conflict between the city-states of Athens and Sparta which in the end ruined both. He died before his book was finished. It is one of the most brilliant, painstaking and dependable histories ever written. It is studied in our colleges by students of the Greek language, for Thucydides' style is a masterly example of Greek noble prose.

THUCYDIDES' TRIBUTE TO ATHENS, THE CITY HE ADORED

Thucydides is famous also for a FUNERAL ORATION which he wrote (431 B.C.) in memory of Athenians who had fallen in the war against Sparta. In the oration he praised the fallen; then follows a glorious tribute to the city. From this oration we get a picture of Athens at its very peak—the center of the world in all branches of learning, thought and endeavor.

Xenophon's (about 436-355 B.C.) great work is the ANABASIS, which means THE GOING UP. It is the story of an expedition made by some 10,000 Greeks who marched into Asia Minor to aid, for pay, a Persian prince, Cyrus, against his brother, King Artaxerxes. Xenophon was a volunteer in this army. The expedition failed, and the Greeks were left without a leader, far from home and surrounded by foes. Then Xenophon stepped forward and became the leader. The Anabasis tells with mounting excitement the adventures of the dwindling force on the long march home, through enemy country.

THE GREAT TRAGIC PLAYS, CROWNING GLORY OF GREEK WRITING

The crowning glory of Greek literature is in the dramatic field of tragedy; and in this field only one other writer in all the world's history—Shakespeare—can be compared with three great Greeks: Aeschylus, Euripides and Sophocles. Greek tragic plays were state affairs, and had a religious background. They were produced as competitions for prizes. Many of the famous plays were presented for the first time at the Olympic games, at which writers from all the city-states were invited to compete. Actors were paid by the government. Aeschylus himself was an actor for many years. Sophocles was an actor in his youth, so these two "learned by doing" how to write for the stage.

The important actors in the tragedies wore rich costumes, covered their faces with masks, and increased their height by wearing sandals with thick soles (buskins). Some of the story, as it unfolded on the stage, was recited, the rest was sung. There were main characters, persons with smaller parts, and members of the chorus. The leader of the chorus was a link between the actors on stage and the audience. He made comments on the play, from the point of view of the audience, as it went along. Greek audiences had a vast store of patience. They could sit for hours before a spectacle of the utmost tragedy. Aristotle said the tragedies washed men's souls clean.

Aeschylus, who lived from about 525 to 456 B.C., was born at Eleusis, of noble family. He wrote between seventy and ninety tragedies, of which almost sixty won prizes in the competitions. Only seven have come down to us: Agamemnon, Choëphorae and Eumenides, (The Furies), which tell the grandly terrible story of the ill-fated family of Agamemnon; the Suppliants, The Persians, Seven Against Thebes, and Prometheus Bound. All seven of these tragedies carry us into a sort of majestic superworld peopled by men and women whom the gods have marked out to wear glory, to bear sorrow and to know the depths of fear. There is grandeur and noble pathos in the plays of Aeschylus; but the people are not flesh-and-blood everyday mortals as we know them.

THE CHARACTERS IN SOPHOCLES' PLAYS SEEM LIKE REAL PEOPLE

Sophocles made his characters more understandable, more human than those of Aeschylus. Sophocles was born near Athens about 497 B.C. His family was rich and the boy was well educated. He had musical talent, played the lyre and composed lyric poems. Before he was thirty years old he had written a tragedy for a competition that won first prize, even over Aeschylus. Sophocles won, in all, twenty first prizes in sixty-three years. It is said that no play of his ever won less than second prize. He probably wrote more than one hundred dramas. Fragments of several remain, and seven have been preserved entire. These are Antigone, Electra, Ajax, Oedipus the King, Oedipus at Collonus and Philoctetes.

His record of work seems all the more remarkable when we remember that Sophocles also for many years held government office, and took part in the social life of Athens. This was the time of Pericles, the Golden Age of Athens. Great writers, great builders and sculptors, great thinkers, scientists, teachers and leaders in government, worked prodigiously. Genius was almost commonplace, in the Athens of those days. Aeschylus, Sophocles and Euripides were all men of the Golden Age, which extended from about 459 to 429 B.C. You can make a list of other men of the Golden Age mentioned in this article, by noting their dates.

EURIPIDES WHO WON HIS SUCCESSES BY HARD EFFORT

Sophocles lived from about 496 to 406. Euripides was born in 480 and died in 406, so you see he was about seventeen years younger than Sophocles. He was born, so they say, in Salamis the day of the great sea fight with the Persians. Euripides was not of noble birth, nor was he rich. He was largely self-educated; all his life he was a great reader, not interested in public life nor in society.

When he was twenty-five years old (in 455) Euripides entered a dramatic contest, but won only third prize. From that time on he entered almost every competition, but not until 440 did he win a first prize, and he won only five first prizes in the thirty-nine in which he competed. After his death his popularity increased. He wrote between seventy-five and ninety-two tragedies, of which nineteen are preserved. The best of these are Alcestis, Medea, Helena, Iphigenia at Aulis, Iphigenia at Taurus, Orestes, Hippolytus Crowned, The Troades, The Bacchae, and Electra.

EURIPIDES SUGGESTS THAT OUR OWN PERSONALITY CAUSES OUR FATE

Most of these have a woman as chief character, or else revolve about a woman. Euripides loved to write about human emotion, and the strange course of human life. Aeschylus was grand, even terrifying. Sophocles was filled with pity for the men and women chosen by the gods to be great and to suffer. Euripides suggests that the tragedies of mankind are not imposed by gods, but rather, caused by human character.

There were other tragic poets, of course, but none fit to rank with the three masters. Greek comedy, which had its beginning in ancient rustic chants, grew slowly. Not until the fifth century did it have any importance as literature or have a place in the competitions. The chief name in Greek comedy is Aristophanes, the Athenian (448-380). He won second prize when he was only twenty-three years old, for the Banqueters. The Golden Age was waning. Pericles was dead, and the city government had sunk from its high state. What we would call grafters were in power, under a man named Cleon. Aristophanes wrote a number of comedies (Knights, Wasps and others) making fun of Cleon, and of the Athenians for putting up with such conditions. In Clouds he made fun of modern education. Lysistrata was a play against war. Frogs made fun of Euripides, charging that he had debased tragedy. Aristophanes set out to destroy by ridicule whatever he disliked. Many of his plays are still read for their comic entertainment, though this is often indelicate—even coarse. Later writers of comedy were Menander

(342-291 B.C.), Philemon (360-262), and Alexis (394-288). The Roman writers Plautus and Terence imitated the plays of Menander.

The characters in Greek comedy were dressed in fantastic costumes, and so were the members of the chorus. Dances were undignified and there was a good deal of hearty, vulgar confusion. The chorus of comedy had twenty-four dancers, where tragedy had twelve, or at most fifteen.

SOCRATES AND HIS EVEN MORE CELEBRATED PUPIL BOTH TAUGHT IN THE ACADEMY

In philosophy, as in drama, Greece leads the world. Several of the great philosophers were followers of Socrates, whose life story we give you on page 6385. Xenophon, author of the ANABASIS, was Socrates' pupil, and he wrote several works on philosophy. By far the most celebrated disciple of Socrates was Plato (427-347), who claimed descent from an ancient king and lived to be a monarch in the realm of thought. He was endowed with many-sided genius. He studied poetry and music and painting and science. When he was twenty years old he met Socrates, and gave up all other interests but the search for truth. When Socrates had been put to death for teaching "dangerous doctrines," his friends fled from Athens; and so it was that Plato traveled widely, to Italy and Sicily.

PLATO WHO CARRIED ON WHERE SOCRATES LEFT OFF

Back in Athens at last, Plato began to teach in the Academy, and there he stayed for forty years. His writings include more than forty dialogs (conversations) and thirteen letters. It is said that "as a philosopher Plato continues Socrates and yet surpasses him in every sense." In fact, it is hard to know where Socrates ends and Plato carries on, in the so-called Socratic dialogs. In these, the thought, the teachings, are all put in the mouth of Socrates.

In the REPUBLIC, Plato gives a view of an ideal state as he would like to see it. In it he plans three classes: workmen, including farmers and merchants; guardians, that is "security men", soldiers; and magistrates, who would be the teachers as well. Women are on equal plane with men. Children are brought up by the state. There is something sublime, yet cold, about the republic described by Plato.

The grandest of Plato's students was Aristotle (384-322). He was probably the greatest scientist of antiquity, and we speak of him in our Men of Science, page 588. Aristotle's writings include letters, poems, dialogs, and scientific papers. Best known are his treatises on Natural History, Rhetoric, Poetics and Ethics.

ARISTOTLE, PUPIL OF PLATO, WHO SURPASSED HIS MASTER

In the ETHICS, Aristotle suggested that the happy man is the one who seeks the middle way—not too much nor too little of anything. "The golden mean," he called it. He thought that virtue could be cultivated, until it became a habit, and many philosophers and teachers to this day have agreed with him. The POETICS is a treatise on art, chiefly epic and dramatic poetry.

Rhetoric and oratory as forms of prose developed late in Greece. Lysias (432?-350?); Isocrates (436-338); Lycurgus and Demosthenes (383-322) were the great names. Another orator, Phocion, is remembered for a remark he made when asked why he was still opposing war. "I am waiting," he said, "until the young men are willing to take to the field, the rich to pay their war tax and the orators to cease cheating the people." We tell you about Demosthenes on page 1611.

Lycurgus (390-324) was an Athenian of rich and noble birth. He probably studied under Plato. He held a position of financial trust in the city, and was a sort of public prosecutor. The only oration of his that is left shows a noble style, impassioned yet coldly logical.

THE IDYLS OF THEOCRITUS SET A FASHION IN POETRY COPIED FOR CENTURIES

The last great writer of whom we shall speak was Theocritus of Syracuse, who lived in the third century, B.C. He excelled in composing short poems of the sort which we call idyls. They sing of the simple joys of the shepherd's life, in tune with Nature, apart from the cares of this world. And so we round out a circle, for you will remember that we mentioned the songs of shepherds among the first bits of what we could call literature. These idyls of the third century were, to be sure, very different from those early unstudied outpourings. They were, in fact, polished and worked over until they were gems of language. They set a fashion in poetry which has never died. English poetry of the seventeenth century was rich in idyls after the manner of Theocritus; some are still being written.

THE NEXT STORY OF LITERATURE IS ON PAGE 5907.

FRENCH—*The Lost Key*

First line, French; second line, English word; third line, as we say it in English.

Il est dix heures et demie.
It is ten hours and half.
It is half-past ten.

Quelqu'un frappe à la porte.
Someone knocks at the door.
Someone knocks at the door.

La bonne l'ouvre.
The maid it opens.
The maid opens it.

C'est le facteur.
This is the postman.
It is the postman.

Il a apporté un télégramme à papa.
He has brought a telegram to Papa.
He has brought Papa a telegram.

Papa le lit vite.
Papa it reads quickly.
Papa reads it quickly.

Papa dit qu'il doit aller à Londres pour affaires pendant quelque temps.
Papa says that he must to go to London for business during some time.
Papa says that he must go to London on business for a little while.

Maman et la bonne cherchent une valise.
Mamma and the nurse look for a bag.
Mamma and nurse look for a bag.

Elles la remplissent d'habits.
They it fill with clothes.
They fill it with clothes.

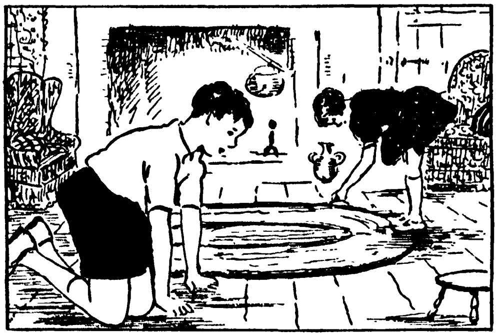
Elles ferment la valise et elles tournent la clef.
They shut the bag and they turn the key.
They shut the bag and turn the key.

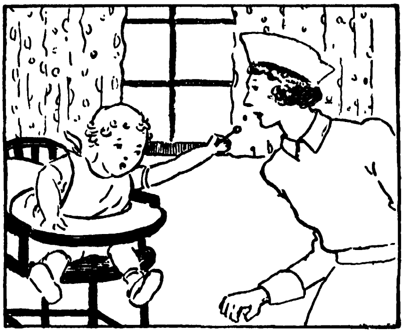
Papa entre.
Papa enters.
Papa comes in.

Il veut mettre un livre dans la valise pour le lire en route.
He wishes to put a book into the bag for it to read in route.
He wants to put a book in his bag to read on the way.

"Où est la clef?" demande papa.
"Where is the key?" demands Papa.
"Where is the key?" asks Papa.

Nous ne pouvons pas la trouver.
We (not) are able not it to find.
We can not find it.





Il faut qu'il arrive à temps pour le train, et il se fait tard.
It is necessary that he arrive at time for the train, and it itself makes late.
He must be in time for the train, and it is getting late.

Nous cherchons sur la table, sur le plancher, et sous le sofa.
We search on the table, on the floor, and under the sofa.
We search on the table, on the floor, and under the sofa.

Elle est perdue.
It is lost.
It is lost.

Puis la bonne crie: "Le vilain!"
Then the nurse cries: "The naughty one!"
Then nurse cries: "Naughty child!"

La clef est dans la bouche de Bébé!
The key is in the mouth of Baby!
The key is in Baby's mouth!

The Taming of the Shrew*

From Tales from Shakespeare *by* Charles and Mary Lamb

Illustrated by Elinore Blaisdell

Katharine, the Shrew, was the eldest daughter of Baptista, a rich gentleman of Padua. She was a lady of such ungovernable spirit and fiery temper, such a loud-tongued scold, that she was known in Padua by no other name than Katharine the Shrew. It seemed very unlikely, indeed impossible, that any gentleman would ever be found who would venture to marry this lady, and therefore Baptista was much blamed for deferring his consent to many excellent offers that were made to her gentle sister Bianca, putting off all Bianca's suitors with this excuse, that when the eldest sister was fairly off his hands, they should have free leave to address young Bianca.

It happened, however, that a gentleman, named Petruchio, came to Padua, purposely to look out for a wife, who, nothing discouraged by these reports of Katharine's temper, and hearing she was rich and handsome, resolved upon marrying this famous termagant, and taming her into a meek and manageable wife. And truly none was so fit to set about this herculean labor as Petruchio, whose spirit was as high as Katharine's. He was a witty and most happy-tempered humorist, and withal so wise, and of such a true judgment, that he well knew how to feign a passionate and furious deportment, when his spirits were so calm that himself could have laughed merrily at his own angry feigning, for his natural temper was careless and easy; the boisterous airs he assumed when he became the husband of Katharine being but in sport, or more properly speaking, affected by his excellent discernment, as the only means to overcome, in her own way, the passionate ways of the furious Katharine.

A-courting then Petruchio went to Katharine the Shrew; and first of all he applied to Baptista, her father, for leave to woo his *gentle daughter* Katharine, as Petruchio called her, saying archly, that having heard of her bashful modesty and mild behavior, he had come from Verona to solicit her love. Her father, though he wished her married, was forced to confess Katharine would ill answer this character, it being soon apparent of what manner of gentleness she was composed, for her music-master rushed into the room to complain that the gentle Katharine, his pupil, had broken his head with her lute, for presuming to find fault with her performance; which, when Petruchio heard, he said, "It is a brave wench; I love her more than ever, and long to have some chat with her"; and hurrying the old gentleman for a positive answer, he said, "My business is in haste, signior Baptista, I cannot come every day to woo. You knew my father: he is dead, and has left me heir to all his lands and goods. Then tell me, if I get your daughter's love, what dowry you will give with her."

Baptista thought his manner was somewhat blunt for a lover; but being glad to get Katharine married, he answered that he would give her twenty thousand crowns for her dowry, and half his estate at his death. So this odd match was quickly agreed on, and Baptista went to apprize his shrewish daughter of her lover's addresses, and sent her in to Petruchio to listen to his suit.

In the meantime Petruchio was settling with himself the mode of courtship he should pursue; and he said, "I will woo her with some spirit when she comes. If she rails at me, why then I will tell her she sings as sweetly as a nightingale; and if she frowns, I will say she looks as clear as roses newly washed with dew. If she will not speak a word, I will praise the eloquence of her language; and if she bids me leave her, I will give her thanks as if she bid me stay with her a week." Now the stately Katharine entered, and Petruchio first addressed her with "Good morrow, Kate, for that is your name, I hear."

Katharine, not liking this plain salutation, said disdainfully, "They call me Katharine who do speak to me."

"You lie," replied the lover; "for you are called plain Kate, and bonny Kate, and sometimes Kate the Shrew: but, Kate, you are the prettiest Kate in Christendom, and therefore, Kate, hearing your mildness praised in every town, I am come to woo you for my wife."

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*From TALES FROM SHAKESPEARE. The Children's Bookshelf Edition. Permission of the publishers, The John Winston Co.

A strange courtship they made of it. She in loud and angry terms showing him how justly she had gained the name of Shrew, while he still praised her sweet and courteous words, till at length, hearing her father coming, he said (intending to make as quick a wooing as possible), "Sweet Katharine, let us set this idle chat aside, for your father has consented that you shall be my wife, your dowry is agreed on, and whether you will or no, I will marry you."

And now Baptista entering, Petruchio told him his daughter had received him kindly, and that she had promised to be married the next Sunday. This Katharine denied, saying she would rather see him hanged on Sunday, and reproached her father for wishing to wed her to such a mad-cap ruffian as Petruchio. Petruchio desired her father not to regard her angry words, for they had agreed she should seem reluctant before him, but that when they were alone he had found her very fond and loving; and he said to her, "Give me your hand, Kate; I will go to Venice to buy you fine apparel against our wedding day. Provide the feast, father, and bid the wedding guests. I will be sure to bring rings, fine array, and rich clothes, that my Katharine may be fine. Kiss me, Kate, for we will be married on Sunday."

On the Sunday all the wedding guests were assembled, but they waited long before Petruchio came, and Katharine wept for vexation to think that Petruchio had only been making a jest of her. At last, however, he appeared; but he brought none of the bridal finery he had promised Katharine, nor was he dressed himself like a bridegroom, but in strange disordered attire, as if he meant to make a sport of the serious business he came about; and his servant and the very horses on which they rode were in like manner in mean and fantastic fashion habited.

Petruchio could not be persuaded to change his dress; he said Katharine was to be married to him, and not to his clothes; and finding it was in vain to argue with him, to the church they went, he still behaving in the same mad way, for when the priest asked Petruchio if Katharine should be his wife, he swore so loud that she should, that, all amazed, the priest let fall his book, and as he stooped to take it up, this mad-brained bridegroom gave him such a cuff, that down fell the priest and his book again. And all the

while they were being married he stamped and swore so, that the high-spirited Katharine trembled and shook with fear. Never was there such a mad marriage.

Baptista had provided a sumptuous marriage feast, but when they returned from church, Petruchio, taking hold of Katharine, declared his intention of carrying his wife home instantly: and no remonstrance of his father-in-law, or angry words of the enraged Katharine, could make him change his purpose. He claimed a husband's right to dispose of his wife as he pleased, and away he hurried Katharine: he seeming so daring and resolute that no one dared attempt to stop him.

Petruchio mounted his wife upon a miserable horse, lean and lank, which he had picked out for the purpose, and himself and his servant no better mounted; they journeyed on through rough and miry ways, and ever when this horse of Katharine's stumbled, he would storm at the poor beast, who could scarce crawl under his burden.

At length, after a weary journey, during which Katharine had heard nothing but the wild ravings of Petruchio at the servant and the horses, they arrived at his house. Petruchio welcomed her kindly to her home, but he resolved she should have neither rest nor food that night. The tables were spread, and supper soon served; but Petruchio, pretending to find fault with every dish, threw the meat about the floor, and ordered the servants to remove it; and all this he did, as he said, in love for his Katharine, that she might not eat meat that was not well dressed. And when Katharine, weary and supperless, retired to rest, he found the same fault with the bed, throwing the pillows and bed-clothes about the room, so that she was forced to sit down in a chair, where if she chanced to drop asleep, she was presently awakened by the loud voice of her husband, storming at the servants for the ill-making of his wife's bridal-bed.

The next day Petruchio pursued the same course, still speaking kind words to Katharine, but when she attempted to eat, finding fault with everything that was set before her, throwing the breakfast on the floor as he had done the supper. Katharine, the haughty Katharine, was fain to beg the servants to bring her secretly a morsel of food; but they, being instructed by Petruchio, replied they dared not give her anything unknown to their master. "Ah," said she, "did he marry me to famish me? Beggars that come to my father's door have food given them. But I, who never knew what it was to entreat for anything, am starved for want of food, giddy for want of sleep, with oaths kept waking, and with brawling fed; and that which vexes me more than all, he does it under the name of perfect love, pretending that if I sleep or eat, it were present death to me." Here the soliloquy was interrupted by the entrance of Petruchio: he, not meaning she should be quite starved, had brought her a small portion of meat, and he said to her, "How fares my sweet Kate? Here, love, you see how diligent I am, I have dressed your meat myself. I am sure this kindness merits thanks. What, not a word? Nay, then you love not the meat, and all the pains I have taken is to no purpose." He then ordered the servant to take the dish away.

Extreme hunger, which had abated the pride of Katharine, made her say, though angered to the heart, "I pray you let it stand."

But this was not all Petruchio intended to bring her to, and he replied, "The poorest service is repaid with thanks, and so shall mine before you touch the meat."

On this Katharine brought out a reluctant "I thank you, sir."

And now he suffered her to make a slender meal, saying, "Much good may it do your gentle heart, Kate; eat apace! And now, my honey love, we will return to your father's house, and revel as bravely as the best, with silken coats and caps and golden rings, with ruffs and scarfs and fans and double change of finery;" and to make her believe he really intended to give her these gay things, he called in a tailor and a haberdasher, who brought some new clothes he had ordered for her, and then giving her plate to the servant, before she had half satisfied her hunger, he said. "What, have you dined?"

The haberdasher presented a cap, saying, "Here is the cap your worship bespoke;" on which Petruchio began to storm afresh, saying the cap was moulded in a porringer, and that it was no bigger than a cockle or walnut shell, desiring the haberdasher to take it away and make it bigger.

Katharine said, "I will have this; all gentlewomen wear such as these." — "When you are gentle," replied Petruchio, "you shall have one too, and not till then." The meat Katharine had eaten had a little revived her fallen spirits, and she said, "Why, sir, I trust I may have leave to speak, and speak I will: I am no child, no babe; your betters have endured to hear me say my mind; and if you cannot, you had better stop your ears." Petruchio would not hear these angry words, for he had happily discovered a better way of managing his wife than keeping up a jangling argument with her; therefore his answer was, "Why, you say true; it is a paltry cap, and I love you for not liking it."—"Love me, or love me not," said Katharine, "I like the cap, and I will have this cap or none."—"You say you wish to see the gown," said Petruchio, still affecting to misunderstand her. The tailor then came forward and showed her a fine gown he had made for her. Petruchio, whose intent was that she should have neither cap nor gown, found as much fault with that. "O mercy, Heaven!" said he, "what stuff is here! What, do you call this a sleeve? it is like a demicannon, carved up and down like an apple tart." The tailor said, "You bid me make it according to the fashion of the times;" and Katharine said, she never saw a better fashioned gown. This was enough for Petruchio, and privately desiring these people might be paid for their goods, and excuses made to them for the seemingly strange treatment he bestowed upon them, he with fierce words and furious gestures drove the tailor and the haberdasher out of the room; and then, turning to Katharine, he said, "Well, come, my Kate, we will go to your father's even in these mean garments we now wear." And then he ordered his horses, affirming they should reach Baptista's house by dinner-time, for that it was but seven o'clock. Now it was not early morning, but the very middle of the day. Katharine spoke modestly, being almost overcome by the vehemence of his manner, "I dare assure you, sir, it is two o'clock, and will be supper-time before we get there." But Petruchio meant that she should be so completely subdued, that she should assent to everything he said, before he carried her to her father; and therefore, as if he were lord even of the sun, and could command the hours, he said it should be what time he pleased to have it, before he set forward. "For," said he "whatever I say or do, you still are crossing it. I will not go to-day, and when I go, it shall be what o'clock I say it is."

Another day Katharine was forced to practise her newly-found obedience, and not till he had brought her proud spirit to such a perfect subjection that she dared not remember there was such a word as contradiction, would Petruchio allow her to go to her father's house; and even while they were upon their journey thither she was in danger of being turned back again, only because she happened to hint it was the sun, when he affirmed the moon shone brightly at noonday.

"Now, by my mother's son," said he, "and that is myself, it shall be the moon, or stars, or what I list, before I journey to your father's house." He then made as if he were going back again.

But Katharine, no longer Katharine the Shrew, but the obedient wife, said, "Let us go forward, I pray, now we have come so far, and it shall be the sun, or moon, or what you please, and if you please to call it a rush candle henceforth, I vow it shall be so for me."

This he was resolved to prove, therefore he said again, "I say, it is the moon."

"I know it is the moon," replied Katharine.

"You lie, it is the blessed sun," said Petruchio.

"Then it is the blessed sun," replied Kath-

arine; "but sun it is not, when you say it is not. What you will have it named, even so it is, and so it ever shall be for Katharine."

Now then he suffered her to proceed on her journey; but further to try if this yielding humor would last, he addressed an old gentleman they met on the road as if he had been a young woman, saying to him, "Good morrow, gentle mistress;" and asked Katharine if she had ever beheld a fairer gentlewoman, praising the red and white of the old man's cheeks, and comparing his eyes to two bright stars; and again he addressed him, saying, "Fair lovely maid, once more good day to you!" and said to his wife, "Sweet Kate, embrace her for her beauty's sake."

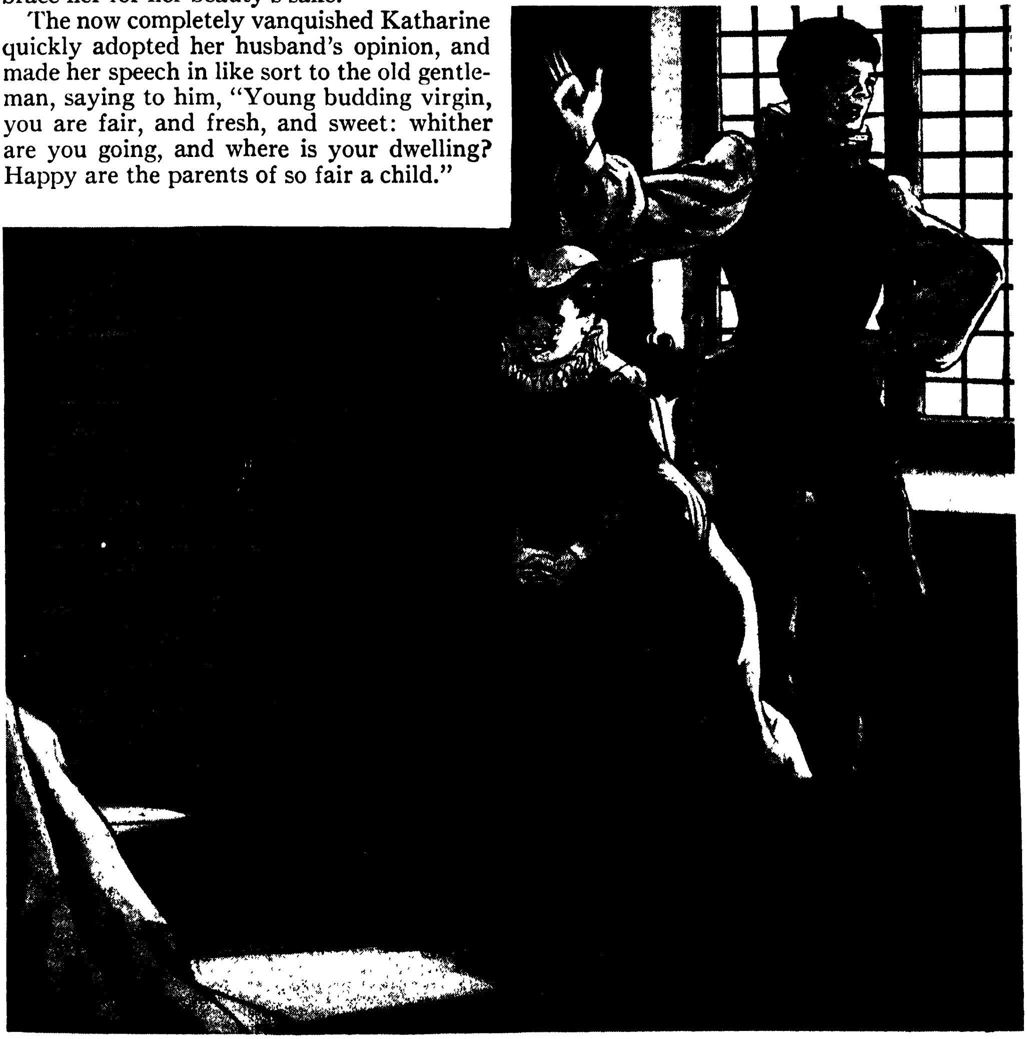
The now completely vanquished Katharine quickly adopted her husband's opinion, and made her speech in like sort to the old gentleman, saying to him, "Young budding virgin, you are fair, and fresh, and sweet: whither are you going, and where is your dwelling? Happy are the parents of so fair a child."

"Why, how now, Kate," said Petruchio; "I hope you are not mad. This is a man, old and wrinkled, faded and withered, and not a maiden, as you say he is."

On this Katharine said, "Pardon me, old gentleman; the sun has so dazzled my eyes, that everything I look on seemeth green. Now I perceive you are a reverend father: I hope you will pardon me for my sad mistake."

"Do, good old grandsire," said Petruchio, "and tell us which way you are travelling. We shall be glad of your good company, if you are going our way."

The old gentleman replied, "Fair sir, and you, my merry mistress, your strange en-



counter has much amazed me. My name is Vincentio, and I am going to the town of Padua to visit a son of mine, who is to be married shortly."

Then Petruchio knew the old gentleman to be the father of Lucentio, a young gentleman who was to be married to Baptista's younger daughter, Bianca, and he made Vincentio very happy, by telling him the rich marriage his son was about to make; and they all journeyed on pleasantly together till they came to Baptista's house, where there was a large company assembled to celebrate the wedding of Bianca and Lucentio, Baptista having willingly consented to the marriage of Bianca when he had got Katharine off his hands.

When they entered, Baptista welcomed them to the wedding feast, and there was present also another newly married pair.

Lucentio, Bianca's husband, and Hortensio, the other new married man, could not forbear sly jests, which seemed to hint at the shrewish disposition of Petruchio's wife, and these fond bridegrooms seemed highly pleased with the mild tempers of the ladies they had chosen, laughing at Petruchio for his less fortunate choice. Petruchio took little notice of their jokes till the ladies were retired after dinner, and then he perceived Baptista him-

“THIS IS A MAN, OLD, FADED — NOT A MAID”

self joined in the laugh against him: for when Petruchio affirmed that his wife would prove more obedient than theirs, the father of Katharine said, "Now, in good sadness, son Petruchio, I fear you have got the veriest shrew of all."

"Well," said Petruchio, "I say no, and therefore for assurance that I speak the truth, let us each one send for his wife, and he whose wife is most obedient to come at first when she is sent for, shall win a wager which we will propose." To this the other two husbands willingly consented, for they were quite confident that their gentle wives would prove more obedient than the headstrong Katharine; and they proposed a wager of twenty crowns, but Petruchio merrily said, he would lay as much as that upon his hawk or hound, but twenty times as much upon his wife. Lucentio and Hortensio raised the wager to a hundred crowns, and Lucentio first sent his servant to desire Bianca would come to him. But the servant returned, and said, "Sir, my mistress sends you word she is busy and cannot come."

"How," said Petruchio, "does she say she is busy and cannot come? Is that an answer for a wife?" Then they laughed at him, and said, it would be well if Katharine did not send him a worse answer.

And now it was Hortensio's turn to send for his wife; and he said to his servant, "Go, and entreat my wife to come to me."

"Oh ho! entreat her!" said Petruchio. "Nay, then, she needs must come."

"I am afraid, sir," said Hortensio, "your wife will not be entreated." But presently this civil husband looked a little blank, when the servant returned without his mistress; and he said to him, "How now! Where is my wife?"

"Sir," said the servant, "my mistress says, you have some goodly jest in hand, and therefore she will not come. She bids you come to her."

"Worse and worse!" said Petruchio; and then he sent his servant, saying, "Sirrah, go to your mistress, and tell her I command her to come to me." The company had scarcely time to think she would not obey this summons, when Baptista, all in amaze, exclaimed "Now, by my *holidame,* here comes Katharine!" and she entered, saying meekly to Petruchio,

"What is your will, sir, that you send for me?"

"Where is your sister and Hortensio's wife?" said he.

Katharine replied, "They sit conferring by the parlor fire."

"Go, fetch them hither!" said Petruchio. Away went Katharine without reply to perform her husband's command.

"Here is a wonder," said Lucentio, "if you talk of a wonder."

"And so it is," said Hortensio; "I marvel what it bodes."

"Marry, peace it bodes," said Petruchio, "and love, and quiet life, and right supremacy; and, to be short, everything that is sweet and happy."

Katharine's father, overjoyed to see this reformation in his daughter, said, "Now, fair befall thee, son Petruchio! you have won the wager, and I will add another twenty thousand crowns to her dowry, as if she were another daughter, for she is changed as if she had never been."

"Nay," said Petruchio, "I will win the wager better yet, and show more signs of her new-built virtue and obedience." Katharine now entering with the two ladies, he continued, "See where she comes, and brings your froward wives as prisoners to her womanly persuasion. Katharine, that cap of yours does not become you; off with that bauble, and throw it under foot." Katharine instantly took off her cap and threw it down upon the ground.

"Lord!" said Hortensio's wife, "may I never have a cause to sigh till I am brought to such a silly pass!"

And Bianca, she too said, "Fie, what foolish duty call you this?"

On this Bianca's husband said to her, "I wish your duty were as foolish too! The wisdom of your duty, fair Bianca, has cost me a hundred crowns since dinnertime."

"The more fool you," said Bianca, "for laying on my duty."

"Katharine," said Petruchio, "I charge you tell these headstrong women what duty they owe their lords and husbands." And to the wonder of all present, the reformed shrewish lady spoke as eloquently in praise of the wifelike duty of obedience, as she had practised it implicitly in a ready submission to Petruchio's will. And Katharine once more became famous in Padua, not as heretofore, as Katharine the Shrew, but as Katharine the most obedient and duteous wife in Padua.

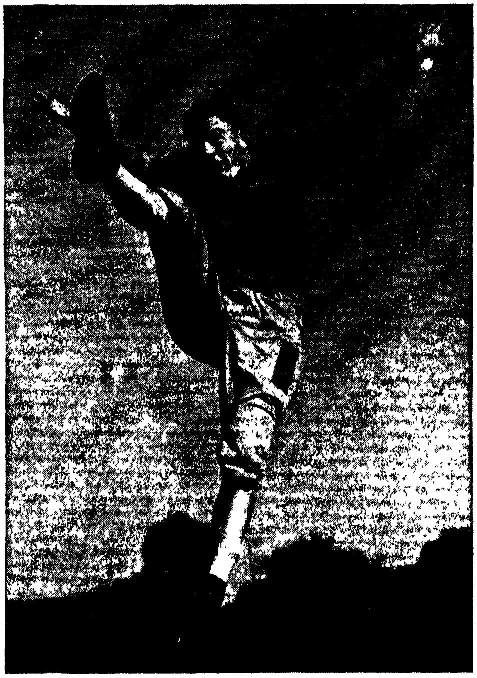
THE NEXT STORIES ARE ON PAGE 6095.

AMERICAN FOOTBALL

THE game of football goes back several thousand years. The ancient Greeks played a game called *harpaston,* in which a ball was passed, carried or kicked across a goal line. The Romans had a somewhat similar game, in which the *follis,* a leather ball inflated with air, was struck by the arm or hand. Various games like these were also played in the Middle Ages, particularly in England and in Italy.

By the end of the seventeenth century the game of football had come to be a great favorite in a number of English public schools. The game developed differently in different schools, though kicking always played an important part. In the famous school of Rugby running with the ball and tackling came to be permitted. The variety of football played at Rugby became particularly popular about the middle of the nineteenth century. It was as a reaction against the Rugby influence in football, which tended to restrict kicking, that a group of sportsmen met in England in 1863 and formed what was known as the Football Association. The game fostered by this group was called association football or soccer.

A modified form of Rugby was introduced at Yale University about the middle of the nineteenth century by an undergraduate who had learned the game while attending classes at Rugby. This American version of Rugby won favor among various colleges of the East; in 1872 representatives of Princeton, Yale, Rutgers and Columbia met and formed the first set of rules for the game. American football underwent a series of striking changes, so that the present game differs as much from Rugby as badminton from tennis. Among the men who were instrumental in developing American football were Walter Camp, A. A. Stagg, Fielding H. Yost, Glenn S. Warner and Knute Rockne. The rules for college football do not change much from year to year. Changes in the rules are made by the Football Rules Committee of the National Collegiate Athletic Association.



Courtesy, Univ. of Minnesota News Service

1. An All-American back getting off a fine punt.

Football is now the great American autumn sport. It is played by countless schoolboys in vacant lots and parks and modest athletic fields and by a great number of college players in large stadiums. Professional football also has made great strides, especially since the formation of the National Football League in 1921.

The football playing field is a rectangle, 360 feet long by 160 feet wide, marked out by white lines. At the very ends of the field are the two goals. Each goal consists of two upright posts of wood or of steel, 18½ feet apart, over 20 feet high and with a horizontal crossbar set 10 feet from the ground. Thirty feet from each goal is the goal line, extending from one side of the field to the other. White lines, parallel with the goal lines, run across the field at intervals of five yards. Seen from above, these lines give the field the appearance of a gridron—hence the field is often called a gridiron. The playing field is shown in full detail on page 5765.

The football is an inflated rubber bladder with a leather cover, usually made of pigskin. The ball is not round but drawn out lengthwise into rounded tips at opposite ends. It weighs from 14 to 15 ounces.

The game is played by two opposing

teams of eleven men each. Seven of these men form what is known as the line (they form the first line of defense against the enemy, so to speak); there are four men in the backfield (so called because the men in it must stand at least one yard back of the line). The seven linemen are the center, the left and right guards, the left and right tackles and the left and right ends. The four backs are the quarterback, the left and right halfbacks and the fullback. All these players are provided with uniforms designed to protect them. Each uniform includes a helmet, protective pads for shoulders, hips, thighs and knees, undershirt, jersey and pants, stockings or socks and cleated shoes.

THE TOSS-UP

The object of the game is to score as many points as possible by carrying the ball over the opponents' goal line or by kicking the ball in a certain manner, which we shall describe, over the crossbars of the goal posts. Before the game starts the chief official, the referee, tosses a coin in the presence of the two captains, one of whom calls heads or tails. The winner of the toss has three choices to select from: (1) he may kick off; (2) he may receive the kick-off; (3) he may choose the goal which he is to defend. The loser of the toss has his pick of the two choices that remain.

THE KICK-OFF

The first play of the game is the kick-off, from the 40-yard line of the kicker's side. All of the kicker's teammates, except the man holding the ball on the ground for the kicker, must stay behind the ball. The team that receives the kick is spread over its own territory. No man of the receiving team may stand closer to the ball than his 45-yard line; at least five men must remain between the 45 and 40-yard lines.

The kicker sends the ball in the direction of the receivers' goal. Often the ball is caught or picked off the ground by a member of the receiving team; he runs up the field with the ball until he is tackled by an opponent. If the kick does not carry to the opponents' 45-yard line, the ball is brought back to be kicked over and the kicker's side is penalized 5 yards. If the kick-off goes out of bounds between the goal lines, it must be kicked off again. If it goes out of bounds a second time, the receiving team must put it in play by a scrimmage on the yard-line from which it was kicked. Sometimes the ball goes into the end zone. In that case any man of the receiving team may run with the ball or touch it down. When the ball has been touched down, it is brought out 20 yards from the goal-line and is put in play by the receiving team. This is also true if the ball goes beyond the end zone, or out of bounds between the sides of the end zone.

RECOVERING A FUMBLE

Sometimes, on a kick-off, the ball is fumbled by a member of the receiving team. Any member of the kicking team is entitled to take possession of the ball, if he can get to it before any of his opponents; however, he is not permitted to run with the ball.

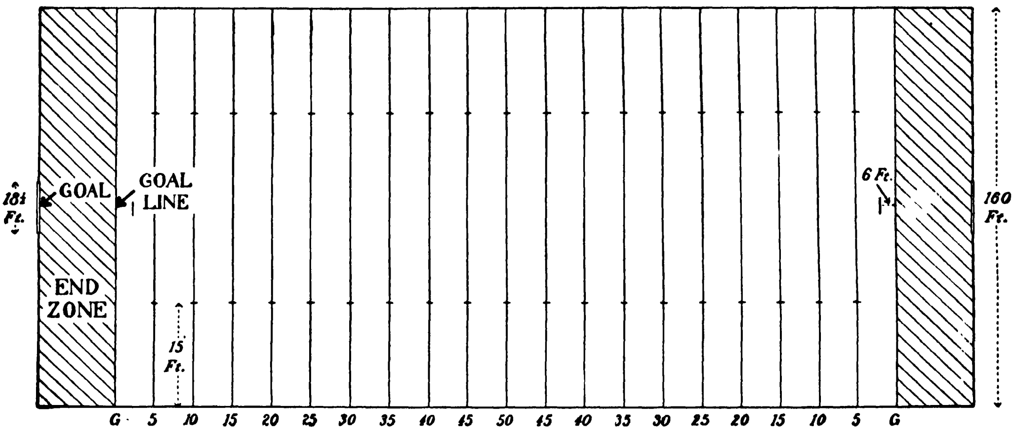
When the ball has become dead after the first kick-off, the first scrimmage of the game takes place. The two teams line up facing each other, the linemen forming two lines parallel to the goal lines; the center of the opposing team squats over the ball. There are a number of possible offensive (that is, attacking) formations as well as defensive formations. Often, before going into formation the members of the attacking team go into a huddle; that is, they gather together forming a circle several yards back of the ball. The players who are in the huddle discuss the next play that is to be run off; then they go into formation. At least one second must elapse after they have gone into formation before the ball can be thrown. The ball is put into play when the center passes the ball between his legs to a man in the backfield.

YARDS AND DOWNS

The attacking team must make at least 10 yards in four downs or tries, or else it must give up possession of the ball to its opponents. If it is successful in making at least 10 yards in four downs or fewer we say that it has made a first down; in that case it has four more downs in which to make 10 yards. Sometimes a team may keep advancing in this way until it has marched the length of the field to a score.

The ball may be advanced in various ways. On running plays one of the backs runs with the ball after he has received a pass directly from the center, or after the ball has been handed or passed to him by another back. Occasionally an end, starting from his position, receives the ball from a back and runs with it. The end's teammates try to block the opponents out of the play. In doing so they must not use hands or arms unless the arms are held close to the body.

The defensive players try to tackle the runner, who is allowed to use his arms and hands in warding off tacklers. Defensive players may also use their arms and hands in pushing blockers aside. In most tackles the runner is thrown to the ground. However, he is considered to be tackled and the ball becomes dead if either one of his knees touches the ground—even if he trips, with no opponent near him. The ball also becomes dead when the runner is so hemmed in that he can neither advance nor fall. If the runner fumbles, the ball may be recovered by a player of either side. The man who recovers cannot run with the ball.



2. Diagram of the football field.

A dramatic method of advancing the ball is by passing it. One of the backs, after receiving the ball, throws it forward, from a point at least 5 yards back of the line of scrimmage, to any teammate who, at the beginning of play, was stationed at either of the two ends of the line or at least one yard behind the line. This is called a forward pass. If the ball falls to the ground without being caught, it is a dead ball; the ball is brought back to the original scrimmage line. If the ball intercepted by an opponent, he may run with it; thus the defending team becomes the attacking team.

The ball may be passed sideways or backward by a ball-carrier without any restrictions at all. This is called a lateral pass; it may be made anywhere back of or ahead of the line of scrimmage. If the ball is dropped by the man for whom the lateral is intended, the ball is brought back to the line of scrimmage.

The ball is sometimes advanced by means of a kick, called a punt. In punting, the ball is tossed up for a short distance by the kicker and then is kicked before it touches the ground. Often a punt is caught on the fly or on the bounce or the ball is picked off the ground by a member of the receiving team; in that case he runs toward the kicker's goal until he is tackled. If a member of the kicker's team reaches a punted ball before a member of the receiving team, he may down it. The receiving team then takes possession of the ball at the place where it was downed. If a punt goes out of bounds, the ball is brought 15 yards in from the place where it left the playing field. If the punt goes over the goal line and is downed by a member of the receiving team, a touchback results. The receiving team takes possession of the ball on the 20-yard line. It is considered good strategy to punt on fourth down, in order to keep the ball as far from one's own goal as possible.

The receiver of a punt, particularly if he sees himself hemmed in by several of his opponents, may signal for a fair catch by raising one hand. His opponents must make no attempt to tackle him; for his part, the player making the fair catch is not permitted to take more than two steps after catching the ball. After a fair catch, the receiving team has its choice of putting the ball in play from scrimmage or of having a free kick at the ball.

If a punt is blocked by a member of the opposing team, any player of either team may pick up the ball and run with it. However, while it is perfectly legal to block the kick, members of the defending team must not run into the kicker or a penalty results.

If either side breaks the rules of the game, a penalty is imposed. There are a great number of different penalties; here are some important ones. If a player of either side crosses the scrimmage line before the ball is snapped, an offside penalty of 5 yards is called. A penalty of 5 yards is also charged for delaying the game. Fifteen yards is the penalty for illegal holding by the attacking team; 5 yards if committed by the defending team. The same penalty is called for unnecessary roughness and for clipping (blocking a man from behind). If a player deliberately strikes or kicks an opponent, he is removed from the game; his team is penalized 15 yards.

FACTS ABOUT PENALTIES

If a penalty of 5 yards, say, is called against the defending team, the attacking team subtracts 5 yards from the total required to make a first down. If the penalty is called against the attacking team, the yardage in question is added to the number of yards required for a first down. A team may decline to accept a penalty called against an opponent. In cases where the penalized team is within the penalized yardage of its own goal line, the ball is put in play on the one-yard line.

The ball may be sent out of bounds as a result of a fumble or it may be carried out of bounds deliberately by a runner in order to avoid enemy tacklers. In that case the ball is brought in 15 yards from the place where it went out of bounds and it remains in possession of the team that had last touched the ball.

SENDING IN SUBSTITUTES

One or more substitutes may be sent in to replace players on either team at any time when the ball is not in play. Any one of the players may be sent into the game any number of times.

There are various scoring plays in football. If a player kicks the ball over the goal-posts of his opponent as a result of a place-kick or a drop-kick, 3 points are added to his team's score. In a place-kick the ball, after being passed from scrimmage by the center, is quickly put into kicking position on the ground by a teammate of the kicker. In the case of a drop-kick, the ball is passed directly to the kicker and he lets it drop to the ground before kicking it. If he kicks the ball before it touches the ground, it is considered to be a punt and it does not count as a score even if it sails over the crossbars.

SCORING A TOUCHDOWN

When a player carries the ball across his opponent's goal line, either by a running play or as the result of a forward pass, he scores a touchdown, or 6 points for his team. The scoring team can now try for an extra point after touchdown. The ball is placed on the 2-yard line, at a place midway between the sidelines. The team in possession of the ball may score an extra point by drop-kicking or place-kicking the ball between the bars, by carrying the ball or by forward or lateral passing.

When a ball carrier is downed in the end zone behind his own goal line after a play from scrimmage or after recovering his teammate's blocked kick, a safety is scored and 2 points are added to the opponents' score. After a safety, the team that has just been scored on has a free kick on or behind its 20-yard line.

After the try for point after touchdown or after a field goal has been scored, the team that has been scored on has the choice of either kicking off or receiving a kick-off. This is from the 40-yard line, as in the case of the opening kick-off.

PLAYING TIME

It takes several hours to play a football game, but the actual playing time for a regulation college game is 60 minutes. There are four quarters of 15 minutes each. There is an intermission of 1 minute between the first and second quarters and the third and fourth quarters; there is an intermission of 15 minutes between halves. The quarters may be shortened by mutual agreement between the two teams. High school teams generally play 12-minute quarters; junior high school teams, 8-minute quarters.

The two teams change goals at the end of the first and third periods. Play is resumed again after the one-minute intermission with the ball occupying the same relative position with respect to the defenders' and attackers' goals. That is, if the ball was on Team A's 30-yard line when the quarter ended, it is placed on Team B's 30-yard line. Play then continues as if no intermission had taken place.

After the first half, however, play definitely comes to an end; the second half

Photo by J. M. Lewis

3. **A touchdown following a forward pass. Not a hand has been laid upon the receiver of the pass.**

begins with another kick-off. At the beginning of the second half the team that received the opening kick-off in the first half now kicks off. Each team defends the same goal it did in the second quarter; it changes goals with its opponent, as we have seen, after the third quarter.

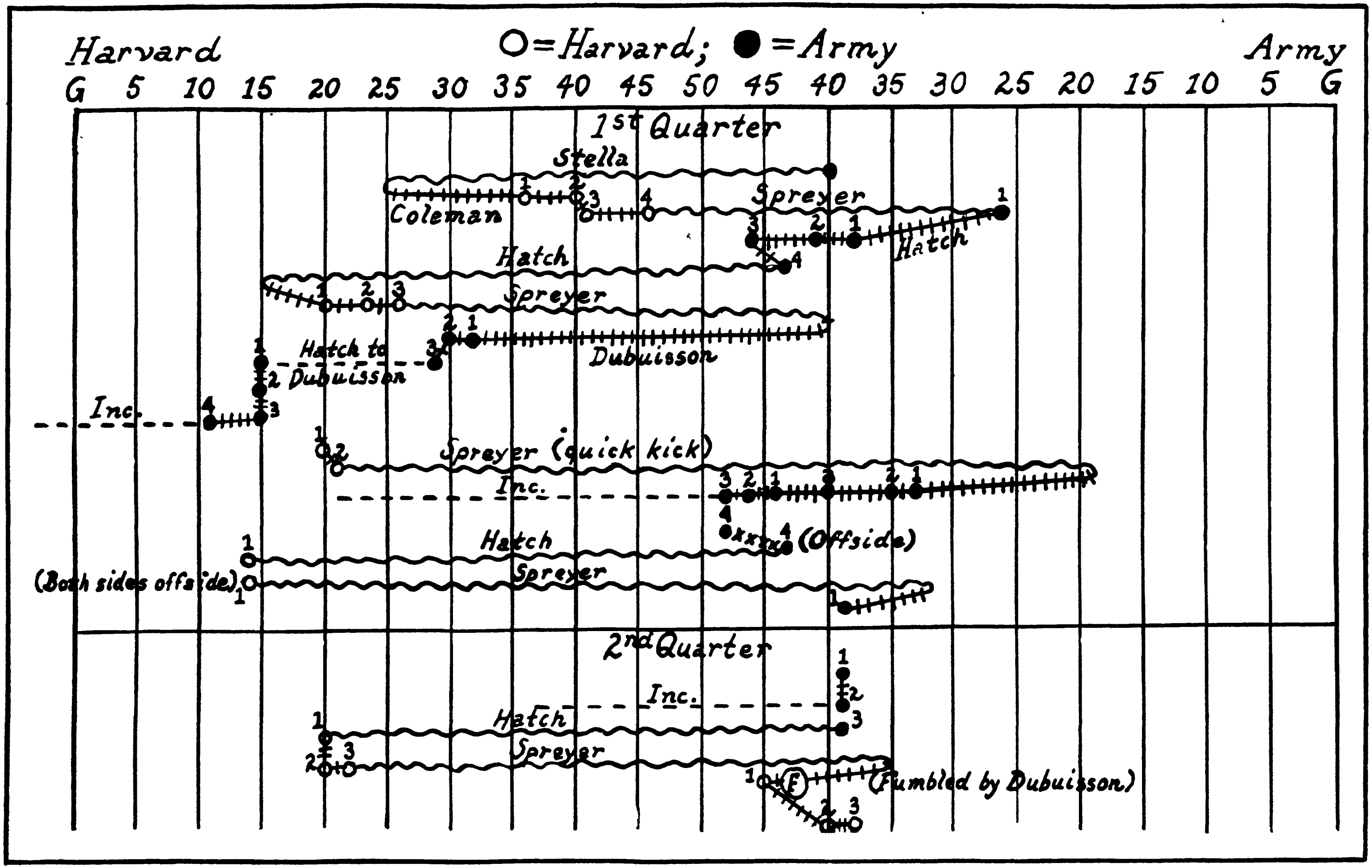
The captain of either team can call for a time-out of 2 minutes at any time during the course of the game. Each team is allowed four times-out for each half. A penalty of 5 yards is charged for each additional one. However, no penalty is charged if a time-out is called for an injury, provided that the injured player leaves the game. Sometimes the referee calls for a time-out; this is not charged to either team.

The football officials include a referee, an umpire, a linesman and a field judge. The referee has general control over the game and he alone can declare the game forfeit to one or the other of the two teams. The umpire has control over the equipment, conduct and position of the players. He blows a horn to indicate that a foul has been committed. The linesman keeps track of the distances that have been won or lost in the various plays. He is also always on the lookout for offside plays. The linesman has several assistants. The field judge times the game by means of a stop watch and he helps the other officials.

The rules for professional football are almost the same as those for the college game. In professional football, however, the goal posts are set on the goal line instead of 10 yards back of this line. Forward passes may be thrown from any point back of the line of scrimmage. A fumbled ball may be picked up and carried toward an opponent's goal line by any member of either team. A runner is not considered to be down until it is impossible for him to advance the ball further (in college football, as we have seen, a runner is considered to be down when either knee touches the ground).

An interesting variation of football is six-man football. In this game there are six players on each team; a center, two ends and three backs. The playing field is 80 yards long by 40 yards wide. A field goal counts for 4 points instead of 3. All players are eligible to receive passes, which may be made from any point beyond the line of scrimmage. Another variety of football is touch football; in this game the ball carrier is not tackled but touched. Touch football is generally informal; almost any number of players may take part. Passing plays a very important part in the game. Although blocking is a recognized feature of touch football, there is comparatively little hard physical contact and as a result injuries are quite rare.

A FOOTBALL CHART THAT RECORDS EACH PLAY



1. A score card, recording play in a Harvard-Army game. The symbols used here and also a detailed account of the first quarter of play are given on page 5769.

HOW TO KEEP SCORE IN FOOTBALL

WHAT is more thrilling than a fine football game, with its stirring runs, its long kicks, its daring forward passes and its colorful crowd! Perhaps after seeing a particularly interesting game or listening to an account of one over the radio, you may wish that you had kept some record of it. In this article we shall show you how you may do so by keeping a play-by-play score of the game.

For this purpose you will have to make a chart with the yard marks indicated as in figure 1. Seven by twelve inches would be a practical size for this chart. If you wish, you may run off a number of copies of the chart by using a hectograph or a mimeographing machine, if one is available in your school.

HOW TO RECORD PLAYS

In recording the various plays of the game, first place the names of the teams over their respective goal lines, as shown in figure 1. In giving the plays, start at the top of the diagram and work your way downward. To indicate which side has the ball, place a small circle at the beginning of each play; use a white circle for your favorite team and a black one for the other side. To indicate the down, place a small numeral over or beside the circle. Figure 2 shows how to record the plays that might come up in a game.

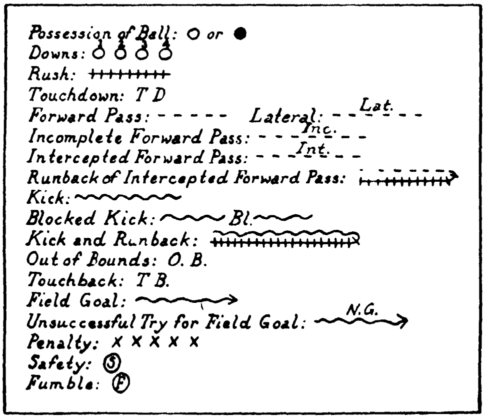
OTHER DETAILS

To indicate which player made a long run or forward pass or kick, simply write his name over or under the appropriate play on your chart, as indicated in figure 1. When a side has scored a touchdown, place the name of the scoring team at the margin with the number of points that it has scored, including this particular touchdown. Other scoring plays are indicated in the same way. To indicate the try for point after touchdown, place a circle on the two yard line and then indicate by the appropriate symbol the play that was attempted. On the margin indicate the total score again; this will show whether the try for point after touchdown was successful.

In figure 1 we show you part of a score card with the record of play of a game between Harvard and Army, as drawn up by the writer of this article. See if you can give a play-by-play description of the game, on the basis of the chart. Then check your results with the following account of the first quarter of play in this interesting game.

Stella kicked off for Army. The ball was taken by Coleman of Harvard at the 25-yard line; he ran the ball back to the 36-yard line. Three running plays were not quite good for a first down. Spreyer then punted for Harvard, the ball being downed on Army's 26-yard line. Hatch of Army made a first down on Army's 38-yard line. Two running plays netted 8 yards, but there was a loss of 3 yards on the next play. As it was fourth down, Hatch kicked a fine punt of 42 yards, the ball being run back to Harvard's 20-yard line.

Harvard made 6 yards on two running plays. Spreyer punted to Army's 40-yard line. The ball was taken at that point by Dubuisson, who made a runback of 28 yards. Army made only 3 yards on two running plays on the next play, however, a forward pass from Hatch to Dubuisson netted 14 yards; it was first down on Harvard's 15-yard line. The Harvard line held on the first two running plays by Army; the next play resulted in a 4-yard gain by Army. Army tried a forward pass to the end zone. The pass was incomplete; Harvard took the ball on the 20-yard line.



2. The scoring symbols.

Harvard made a yard on a running play. A quick kick by Spreyer sent the ball to Army's 19-yard line; the ball was run back 14 yards. Three running plays gave Army a first down; then the Army attack stalled and on fourth down Hatch kicked to Harvard's 14-yard line. Both sides were offside on the next play. Spreyer kicked to Army's 32-yard line. The ball was run back 7 yards as the quarter ended.

HOW TO PRACTICE VENTRILOQUISM

VENTRILOQUISM is the art of producing the voice in such a manner as to make it seem to come not from the speaker but from some place more or less distant from him. The word ventriloquism comes from two Latin words, *venter,* meaning belly, and *loqui,* meaning to speak. You see, people used to think that ventriloquists produced their amazing effects by doing something quite mysterious with the stomach. As a matter of fact, the sounds produced by the ventriloquist are formed by the very same organs that are used in producing ordinary speech—the larynx, the palate, the lips, the tongue and so on.

There are two kinds of ventriloquism: distant ventriloquism and near ventriloquism. Distant ventriloquism is the more spectacular of the two. By controlling the movements of some of the speech organs (particularly the pharynx, the tongue and the lips) the ventriloquist succeeds in apparently throwing his voice in any direction—up, down, to the left, to the right. At one moment the sound seems to be coming from the roof, at another from the cellar, at still another from outside the window.

National Broadcasting Co.
A ventriloquist makes his dummy seem to sing.

In near ventriloquism the performer carries on a conversation with one or more dummies. He uses his natural voice while he himself is supposed to be talking; he uses a voice of entirely different pitch for the dummy. By keeping his lips from moving while the dummy is supposed to be talking and by causing the dummy's lips to move, the near-ventriloquist apparently succeeds in throwing his voice from the dummy's mouth.

Distant ventriloquism is very difficult and requires long hours of study and practice. Near ventriloquism is easier and can be mastered readily by any bright boy or girl who is willing to devote the necessary practice to the art.

The sounds involved in near ventriloquism are produced almost entirely in front of the mouth just behind the teeth and up a little way in the nasal passage. In producing these sounds we must not move our lips. The teeth should just barely touch. The lips should not quite touch; they should be about ¼ inch apart.

Most sounds can be produced quite easily without moving the lips. A few sounds—B, F, M, P and V—offer special difficulty, because the lips play an important part in producing them. We therefore substitute other sounds. M should be pronounced N, the N being pronounced quite indistinctly. In the case of B, F, P and V, likewise, the amateur ventriloquist should make no effort to articulate these sounds clearly. He simply throws his breath very sharply against the upper teeth and he prolongs the sound a trifle.

To acquire skill in speaking without moving the lips, one should practice talking before a mirror. First go over each letter of the alphabet, then practice words and finally complete sentences.

Ventriloquism puts considerable strain upon the vocal organs. For this reason you should never practice more than 15 minutes at any one time. Stop practicing at the first sign of hoarseness. Never practice while you have a cold.

You will find that the other sounds occurring in the intervals between the special breathings required for B, F, M, P and V will make it perfectly clear to the audience what the dummy is trying to say. For example, indicating the special breathings by the letter X, the sentence "I X-ound X-oth these X-yooti-X-ul X-askets" would be easily understood by any audience.

Ventriloquists should be able to pronounce any word, using special breathings as necessary. Many ventriloquists, however, try to eliminate words in which difficult sounds occur. For example, for "both of them" we could substitute "each one of them."

The dummies that professional ventriloquists use can move their lower jaws, roll their eyes, turn their heads, wink knowingly, sneer and grin. Some can even weep bitterly, smoke and walk! Such dummies are generally made to order and are quite expensive. You will find it advisable to begin your career as a ventriloquist with one of the toy dummies that can be bought in toy shops, department stores or drug stores.

These dummies are provided with movable lower jaws, worked by a string. With a dummy of this sort you can practice one of the ventriloquist's most important accomplishments—causing the dummy's lips to move so as to make it appear that the performer's voice is coming from the dummy's lips. You will be able to give a very satisfactory performance with your toy dummy.

HOW DID THE FARMER ENLARGE THE FOLD?

A FARMER had 50 hurdles (a hurdle is a movable framework for making fences or gates). With these hurdles he made a sheepfold that held exactly 100 sheep. Later on, as he had a good deal of fine pasture land, he decided to add to the number of his sheep. So he went to market to buy some more. He had intended to add only 50 more sheep to his flock, but he changed his mind and bought 100.

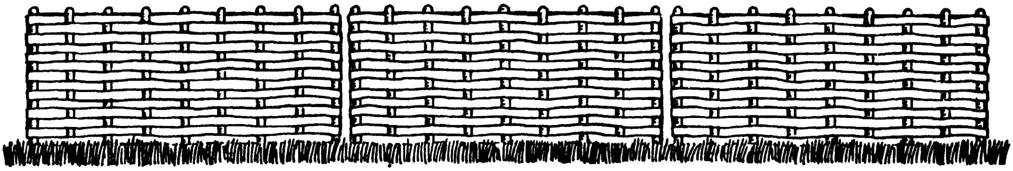


Diagram showing how the hurdles that are described in this puzzle are set side by side.

A friend who had accompanied the farmer to market pointed out that now his sheepfold would have to be twice as large as before; therefore he would have to get a number of new hurdles. The farmer said that he would need only two more hurdles. "Only two more hurdles to give you double the amount of space in your fold? You are mistaken," said the friend. The farmer, however, was sure that he was right, and he bought only two new hurdles. The next day the farmer met his friend again and told him that he had found the two hurdles quite enough to double the amount of space in the fold.

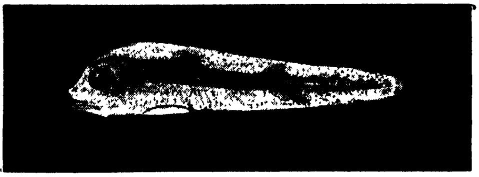
The friend seemed doubtful. So the farmer took him to the field where the fold was, and in a moment the friend saw that the farmer was right. How did he do so much with only two hurdles? The answer to this little problem is given in reversed (upside-down) type below.

HOW THE FARMER ENLARGED THE FOLD

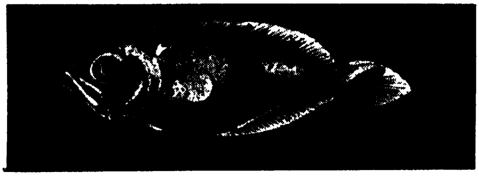
It seems impossible to double the size of a sheepfold made up of 50 hurdles by adding only two extra hurdles; yet it is really quite easy. The original sheepfold mentioned in the above puzzle was a long narrow enclosure, with 24 hurdles on each side and a single hurdle at each end. To double the size of the fold, the farmer simply moved one side further away from the other and placed two hurdles at each end instead of one. In this way he doubled the size of the enclosure and provided plenty of space for his new sheep.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 5885.

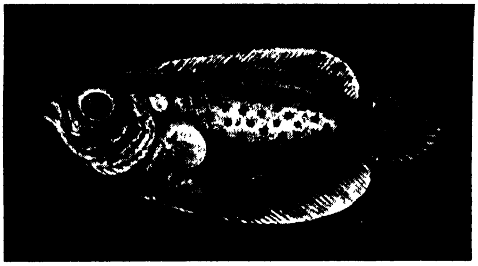
THE AMAZING STORY OF A FLAT FISH



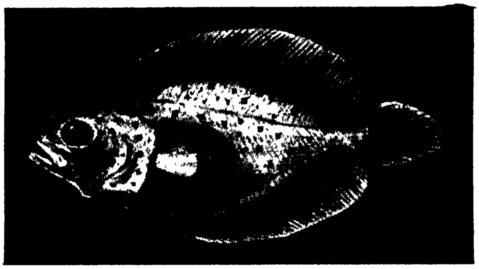
These pictures show the life-story of a young turbot. When hatched from the egg and a day or two old, it is like this, measuring about an eighth of an inch.



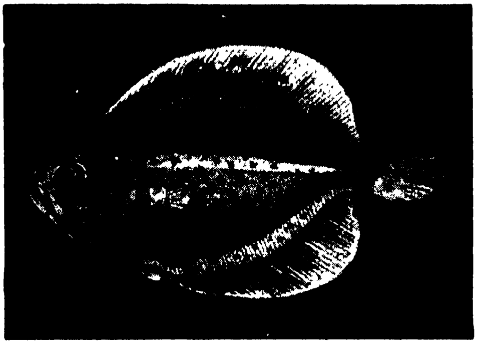
As it grows it changes shape, and when about three-fifths of an inch long it begins to develop spines on the head. These, however, disappear later.



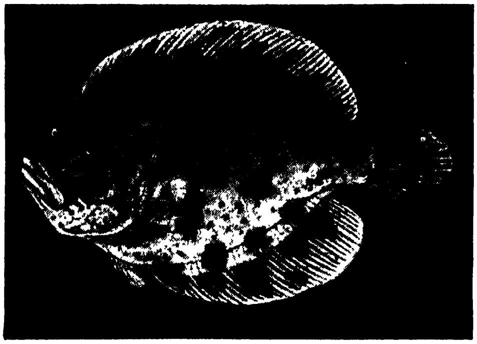
In the early stages of its life it is symmetrical in form, and both sides of its body are colored alike.



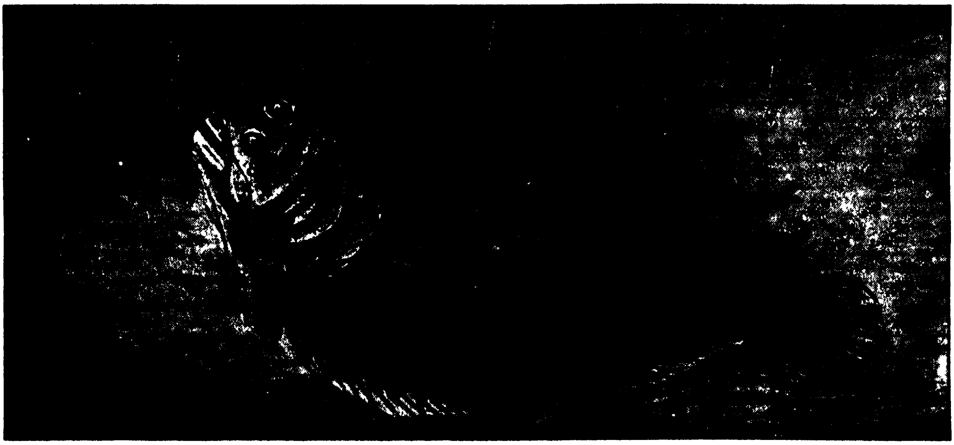
All this time it swims upright, with an eye on each side of its body, so as to see on both sides.



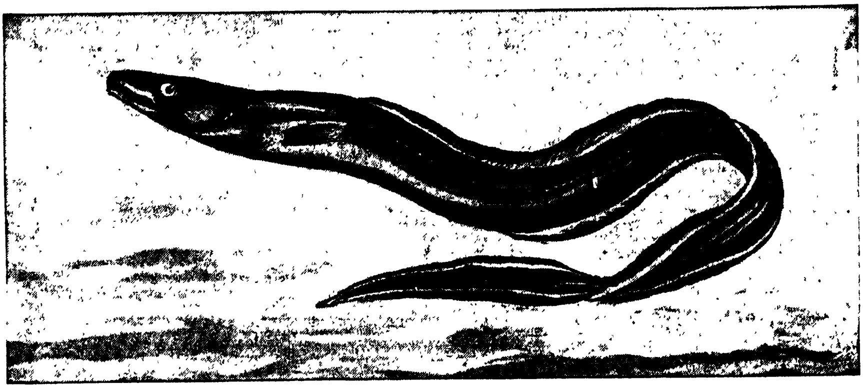
Now an amazing thing happens. One of the eyes begins to travel round the head, as we see here.



It changes its habits, and instead of swimming upright it becomes a flat fish, lying on the bottom.

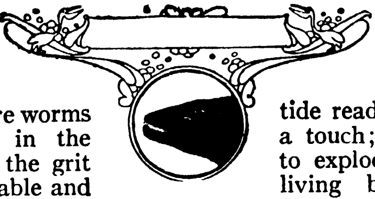


At last the under eye has traveled round to the top side of the fish, and the under-surface becomes white. Other flat fishes change their form and habits in the same remarkable way.



The Conger Eel.

FISHES OF SHALLOW SEAS



WHAT a wonder world it is that lies before us as we stand upon the seashore! There are worms and shelled creatures in the sand and mud, eating the grit and digesting the vegetable and animal matter in it. There are creatures hopping like fleas, creatures to which a piece of seaweed is a living continent; mussels anchored by their own coarse silk to rocks and stones; periwinkles that clatter down the sloping beach when the tide goes out, like sprites in elfin clogs; limpets that gravely march down their rock to feed, and return to exactly the same spot when the tide comes back; and no limpet, for all its perfect accuracy of movement, can see.

There is a crab to catch the moving limpet down in the water. There is a fish to catch the crab. In the warmer waters sponges siphon food-bearing water in and out of their canals; sea-urchins feed and defy capture, thanks to their prickles; starfish open with unaided legs the tight shells of the oyster, though no man can do so with bare hands. Whelks are sawing with their file-like ribbon tongues through the oyster's shell; the sea-anemone swallows the crab which caught the limpet, and the sea-slug and the cod dine on the anemone.

Shrimps and prawns and lobsters are in their pools; cockles in the sands below tide ready to leap like frogs at a touch; brittle-stars prepared to explode into fragments like living bombs if we handle them; living creatures like pens and cucumbers, like lilies and other floral beauties, are in the coastal seas: a rare challenge to the thoughtful mind. They feed in many cases on identical foods, yet each breeds according to its kind. There are things to-day as they were years ago, now turned to fossils which we dig up whenever we excavate the limestone and chalk.

But we must concern ourselves with fish alone, and they have ways and wanderings which perplex the wisest of naturalists. Seeing how important fish are to us, it might be thought that we should by this time know all there is to be known. The truth is, we know very little. Empires have been founded on the herring. The cod, not gold or tales of fairy lands, brought some of our mariner forefathers across the cold Atlantic to fish with bleeding, splitting hands on the Newfoundland banks.

But we do not know all about these fish. We do not know where the herring go when they leave our shores. We do not know where the teeming mackerel spend their winters. We do not know why fish assemble in the billions in which from time to time they appear. We do not even know what all fish eat. They rapidly absorb their food, and when caught, cast it up, either from fright or like a laboring ship which throws its cargo overside to lighten sailing.

MYSTERY SURROUNDS THE MOVEMENTS OF FISHES

We do not know why fish should be capricious, and, having created the fortunes of a town founded on them, desert the waters in which they had abounded and vanish. The sea to which we go for pleasure and health is a domain of mystery which men have been sounding for thousands of years without having touched the depths of knowledge.

In normal times fisheries employ, directly and indirectly, a considerable part of our population. There are in good times thousands of men engaged in fishing, and, whatever their returns to-day, their catches before the World War were worth many millions of dollars every year.

Perhaps we should begin with sharks, but we shall leave them for the next chapter and shall now speak of the shark's kindred, the monkfish and the rays.

The Monkfish, or Angel-fish, is a connecting link between the sharks and rays. This is a hideous brute which lies at the bottom of the water of warm seas. It is invisible in sediment, though five feet long, with a gaping mouth armed with formidable teeth. In addition to multitudes of flat fish, it cracks up lobsters and swallows whelks. The mother fish produces her young alive, twenty at a birth. Very thankful are fishermen when these fishes are caught and put out of the way, as the men say.

HOW THE SKATES SWOOP DOWN ON THEIR PREY

The Skates, or Rays, about our coasts number upward of a dozen species. They are not much smaller than the monkfish, and, like that animal, are ugly, flattened, variously armed with thorns and prickles on the back, as in the Thornback, and with a deadly mail of spines on the whip-like tail. Sluggish in habit, they live largely on shellfish, oysters, mussels, and what not. They also float above other fishes, then swoop on them, surround them with their flapper-like pectoral fins, and devour them.

The so-called Devilfishes of warmer waters belong to this group. They are known to science as Eagle-rays, fish fifteen feet long, which lash out with their muscular tails all barbed with spines from which a rank poison is said to exude. These are rarities in temperate seas, but fishermen in southern waters know them to their cost and loathe them. The power of the eagle-rays to poison is sometimes questioned, but there is no doubt as to the virulence of the Sting-rays of the tropics, which carry poisonous spines seven and eight inches long on the tail, and cause great pain when they strike human flesh. Some of the family are eaten by Europeans, but not often in this country.

We have another northern species of ray which is as interesting as any ray of the whole family, the Torpedo. All the family may have some slight power to give electric shocks, but the torpedo has developed the gift exceptionally. Here is a lowly creature of our inshore deeps, measuring but little and weighing never more than 150 pounds, which has mastered the mystery of the natural electric battery.

The one thing human electricians have not given us is an efficient storage battery: our batteries are always running down. But this humble fish is constantly fully charged without effort or apparent expenditure. A flick of its tail and the fish at which it aims is stunned; and though the torpedo has poor teeth, it has been known to kill and swallow a five-pound salmon. Nature has her own dynamo, we see, and it works perfectly in this ugly fish of our waters.

THE MOTHER-LOVE OF THE TERRIBLE TORPEDO RAY

Nobody likes the rays, and this one is hated perhaps more than the rest. But there is something to be said in its favor. It does realize that it has the power of a giant and restrains itself in the presence of its own. It never emits a charge from its battery when its young are near, lest it should kill them.

It is pleasant to pass from these unlovely fish to handsome coursers which make life seem gay instead of gloomy and horrid near the shore. We have not to go far out to find the gallant Striped Bass, or Rockfish, a perch-like beauty which, though commonly a one- or two-pounder to anglers on the piers and rocks, runs to fifty pounds or more when left to mature. A specimen weighing over a hundred pounds has been taken off Cape Cod. Like the salmon, it comes up the rivers to spawn. In the St. Lawrence it comes at least as far as Quebec. It is a swift, gay fish, but to the sand eels, which constitute a considerable part of its food, it must seem as frightful a thing as a man-eating shark is to a human child.

There are various sea fish more or less related to the bass and sometimes classified in the same group. They are sometimes called Sea Breams. Some weigh as much as ten pounds. A curious and pathetic evidence of the amazing tenacity of life in fishes has been proved by the breams.

For years examples were caught which seemed to possess no upper jaw, though there was no sign of wound. Long research proved that the fish when young were caught nibbling at a bait and were hooked with such violence that their upper jaws were torn away. Yet they survived, healed their hurts, grew great and fat, with half their mouths missing, and in the end came to table.

THE MULLETS AND THE FIERCE BLUEFISH

The Mullet Family is a large one and is found in the shallow waters of the warmer regions of the world. Some species live in fresh water. The Common Mullet is really common on our side of the Atlantic south of Cape Cod. It feeds entirely upon what it finds in the mud of bays and lagoons, and is an excellent food fish. The White, or Blueback, Mullet is found in the same waters, but is less common. The name "mullet" is also incorrectly applied to many fresh-water fish, especially of the Sucker Family. The European Red Mullet belongs to another family. It was much prized by the Romans and is considered a delicacy to-day. Our Red Mullet, also called the Red Goat Fish, is much like it, but is not very abundant.

The Bluefish is the only member of his family, for which other fishes may be thankful. They range the western Atlantic and the Indian oceans like hungry wolves, apparently killing for the joy of slaughter. They do not hesitate to attack other fish almost as large as themselves, eat a few choice bits, and go on to kill others. Fortunately they are among the best of food fishes, and when you eat one you are saving the lives of hundreds of other fish.

The next group is the gorgeous mackerel—for gorgeous they are in the sea and when newly drawn from it. There is not a more perfect fish in the waters, blue and black and olive and silver. They sail the seas with the pace of the fastest destroyer, and half their lives are mystery impenetrable to us.

THE GREAT MACKEREL SHOAL THAT WAS FIFTY MILES ROUND

Why do they shoal in such countless millions? They break up at times into single units and are caught in deep water quite isolated. At other times they are countless. One ship steamed round a shoal fifty miles in circumference, and that was only one shoal of many on the move in the North Sea at the time. So tightly are they packed together that once a great grampus, which follows a mob of seals and eats twenty in succession, was seen practically suffocated by the enormous pressure of mackerel into which he had ventured. The mere weight and mass of the racing fish prevented his rising to the surface to breathe.

But toothed whales, sharks and cod and other hungry creatures follow the mackerel with safety, browsing on them as a cow on grass. If the fish were swimming singly, the big enemy could not thus destroy them.

About fifteen of the sixty species frequent American waters. The Common Mackerel inhabits the whole North Atlantic, and some of the finest fishing vessels seek for them. The Spanish Mackerel does not usually go so far north. It is more slender, but is unmistakably a mackerel, and is perhaps the most delicious of the family. Belonging to the same family is the Tuna, or Tunny, also called the Horse Mackerel. It may reach a length of ten feet and a weight of a thousand pounds or more. It is a game fish, and a fisherman who has landed one after a contest lasting for hours feels well repaid. The Bonitos, found in both Atlantic and Pacific, are other members of the family. When the latter takes the hook it sometimes leaps ten feet out of the water in its struggles.

THE MILLIONS OF HERRINGS THAT COME TO OUR COASTS TO LAY EGGS

The shoals of the Herring are still more numerous in point of individual fishes and total of shoals. They surge up to the land in swarms beyond calculation. It is thought that some shoals contain at least three billion fish.

The herrings are a fascinating mystery. Why do they arrive in successive shoals? Why not all at the same time? Have those which come late farther to swim in from distant ocean deeps? Or is it that the desire to lay their eggs does not ripen till later? And where do they go after they have spawned? Nobody can tell.

The Herring Family is interesting and important. While the Common Herring is probably as abundant in our waters as in European, the fishing is not so important, as our fishermen prefer to seek larger fish. In many parts of Northern Europe a good herring year means prosperity, while a bad year means misery. They are caught in nets, and many of the young are packed and sold as sardines. The California Herring, abundant along the Pacific coast, closely resembles its Atlantic relative.

The true Sardines, however, belong to the Herring Family. They are common in the European Atlantic and in the Mediterranean. Indeed, its name comes from the island of Sardinia. They are also called Pilchards in Europe, and the young packed in oil come to us from across the sea. The California Sardine, abundant in the Pacific, is a true sardine.

Most of the herrings spawn in the open sea, but the one we who live near the sea know best, the Alewife, is anadromous (ascending). In early spring all along the Atlantic coast from the Carolinas northward this little fish enters the streams in thousands to lay its eggs. It is good food, and artificial pearls are made from its scales. Somehow it has managed to get into Lake Ontario and other lakes near the St. Lawrence, and there it lives all the year.

THE SHAD BELONGS TO THE HERRING FAMILY

Perhaps the most delicious of the herrings is the Shad. There are two European species, but our American Shad is more important. This fish enters the streams from Florida to Newfoundland to lay its eggs. Formerly it was one of the commonest and cheapest of fish, but the fishermen put so many nets in its way, and the factories have so polluted the streams, that it has become scarce and expensive. The United States Fish Commission years ago set free many young shad in the Pacific waters, where the fish was not common. They thrived and have become common as far north as Alaska. The only drawback in eating shad is the multitude of tiny bones. The roe taken from the female fish before she has had the opportunity to lay her eggs is a great delicacy.

We can mention only one or two more members of this interesting family. The Sprat of which you read is a small European herring which is salted or smoked. The Menhaden is abundant from Nova Scotia to Brazil. It is probably the most abundant of all our shore fishes. It is not worth much for eating, but it feeds other fish, makes good bait, furnishes a valuable oil, and what is left is good fertilizer.

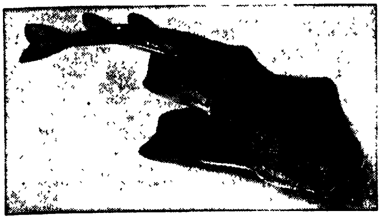
There is another group of small fishes which is much prized, the Smelt Family. They resemble the trout in many ways. The Capelin lives in Arctic waters, and its eggs in the spawning season sometimes cover the shores. The Eulachon, or Candlefish, found on the Pacific coast is so fat that when dried it is sometimes used as a candle. The true smelts are found both in the Atlantic and in the Pacific, entering rivers to spawn. Captain John Smith wrote in 1622: "Of smelts there is such abundance that the Salvages doe take them up in the rivers with baskets like sives." In the East they are often found comfortably living in lakes.

SOME OF THE FISHES WITH SHARP SPINES

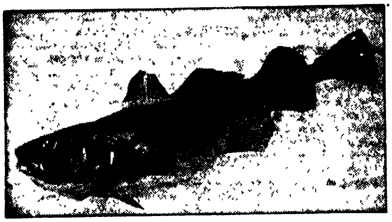
We mentioned the spines of the stickleback in speaking of fresh-water fishes. The sea has many with this means of defense. The Weevers are European fish, and are dangerous to handle because of their sharp spines. The Gurnards, chiefly European, and the Sculpins, or Sea Robins, are hideous in appearance except for their coloring, which is sometimes attractive. You will find some of them shown in our colored plates in this chapter. The Gurnard is supposed to get its name from a French word for "grunt."

Other curious fish are the Gobies, which build nests. After the female has laid her eggs the male watches until they are hatched. The Blenny Family is hardly less interesting, and the members can live out of the water for a considerable time. The Lumpsucker is so

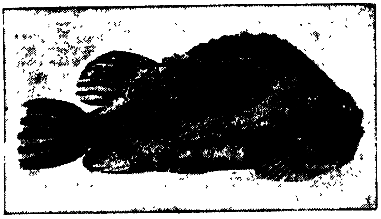
FISHES CAUGHT IN SHALLOW SEAS



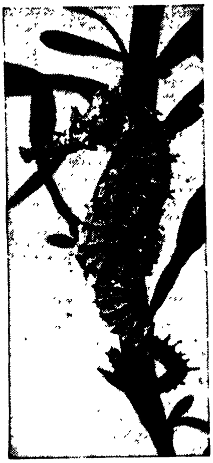
Angel-fish, or monkfish.



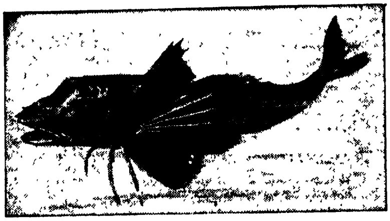
Common cod.



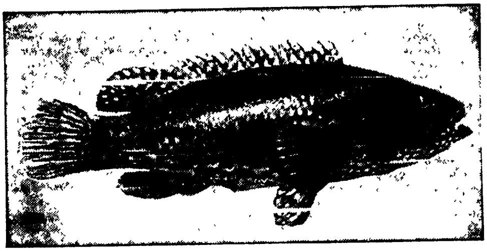
Lumpsucker.



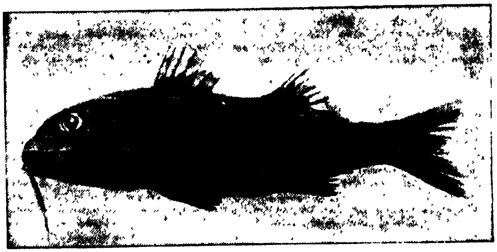
Sea horse.



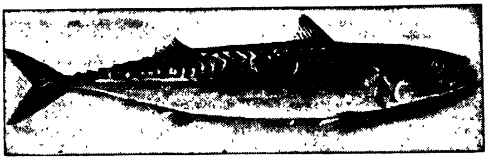
Red gurnard.



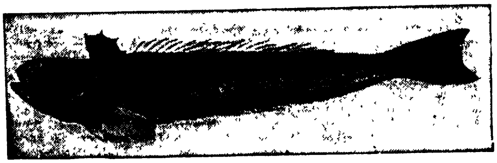
Wrasse.



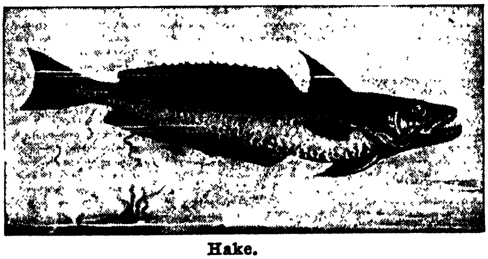
Red mullet.



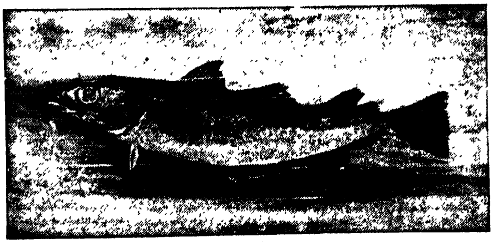
Mackerel.



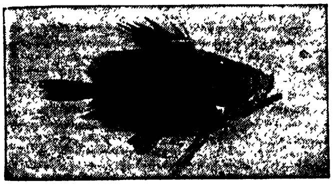
Greater weever, or sting-bull.



Hake.

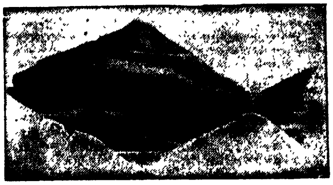


Whiting.



John dory.

Plaice.



Halibut.

The pictures on these pages are by W. S. Berridge and others.

devoted to its eggs that it will remain half exposed if the tide runs out, though sea birds approach to eat it.

THE CHARMING LITTLE SEA HORSE

The sea also has its faithful Sticklebacks, the fifteen-spined; and not far from the haunts of these we find the Pipefish and the Sea Horse, which are as careful of their eggs as the lumpsucker and the stickleback. The Pipefish floats at ease in a straight line; the Sea Horse, so called from the extraordinary resemblance of its head to those old Greek carvings of horses with which we are familiar, has a tail which is as good a grasping organ as the monkey's. It is not much over three inches long.

By its aid the sea horse anchors itself to weeds and other objects and lets food come to it. But it has this in common with the pipefish, its kinsman: like one of the frogs, the sea horse and the pipefish receive the eggs from the female into a brood pouch and keep them there till the babies emerge. In time of danger the little hopefuls return, like baby kangaroos, to the pouch from which they emerged.

Next we come to a very different fish, the Conger Eel, more often seen in shops than by visitors to the seaside. Generally it keeps well out from shore in deep, rocky water by day and comes toward the coast, if at all, only in the night. Seen in the water, a conger six or eight feet long and weighing up toward a hundred pounds must often have given rise to legends of sea serpents. A large female conger is known to have laid over three million eggs. Like the fresh-water eel they die after spawning once.

A DIVER'S ADVENTURE WITH A GIANT CONGER EEL

Their active movements, their snakelike shape, their courage and ferocity, all combine to further the idea. An experienced diver who was repairing the foundations of an old sea-wall was horrified to see the head of a huge creature, which he mistook for a snake, dart out from the wall at him, then as rapidly withdraw. Examination showed that it was a mighty conger trapped in the masonry. By some means it had got into the wall and could not get out.

In general, divers fear congers next to octopuses and sharks, for these eels, once they fix their teeth in an object, will not let go unless they are killed, and even then the jaws have to be pried open. The writer rowed home a mile or more in a storm with a fifteen-pound conger in the boat biting the heel of his shoe with the tenacity of a bulldog.

However, they are clean-feeding creatures, much more particular than the river eels, and they form a valuable food to enormous numbers of poor people in Europe. They are little eaten in this country. They themselves eat great numbers of crabs, lobsters and fish.

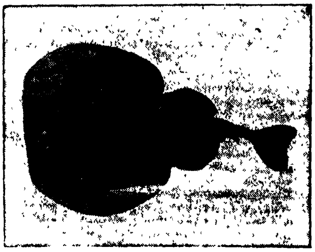
Now let us come to the interesting flatfishes. The Rays are not, properly speaking, flatfish, for they have the back uppermost and the abdominal features beneath, as in the case of reptiles. But the true flatfishes are, every one of them, freaks made permanent. They all begin like other fish, vertical swimmers with a left side and a right side, swimming as upright as herrings, with one eye on one side of the head and the second eye to balance on the opposite side. Early in life these fishes begin to topple over. They flatten out, lying on the side, and the head becomes twisted so as to bring both eyes on the same side. Sometimes one eye makes its way through the head.

THE SLUGGISH CREATURES THAT MOVE LIKE SUBMARINE RAFTS

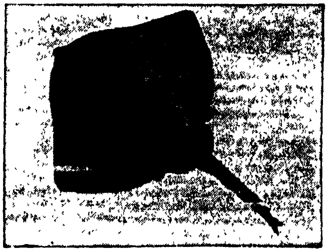
From that time forth the flatfish is a sluggish flopper. Its home is at the bottom of the water, and it moves only by undulating motions, no longer capable of the darting flight through the sea common to its children and to nearly all other kinds of fish.

This Flounder Family is a large one, nearly five hundred species in all, and some of them are found in all seas. They are usually divided into halibut, flounders and turbots, but many of them are called by different names.

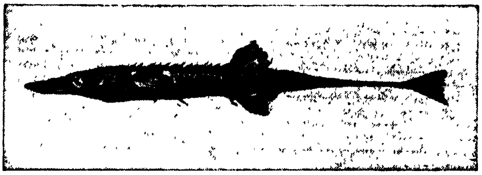
The Halibut proper are fish of the colder waters of the North and are often caught in waters close to the freezing-point. The name means "holy flounder," from the fact that it was commonly eaten on special days set apart by the Church. The Common Halibut is found both in the Atlantic and in the Pacific. It is the largest of the flatfishes and may reach a weight of five hundred pounds. The smaller Arrow-toothed Halibut is common in the Pacific, while the Greenland Halibut is found only in the Atlantic. The under-side of this species is somewhat colored, showing that it probably swims more like an ordinary fish. Several smaller fishes called by various names are closely akin. For example, the Summer Flounder belongs to the group.


Torpedo, or Electric Ray.

Brill.

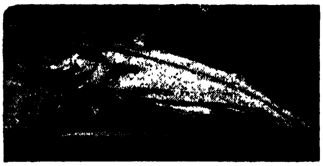

Skate.

Great Pipefish.


Fifteen-spined Stickleback.

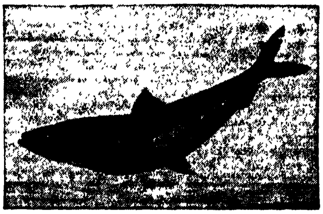
Sea Bream.

Dab.


Haddock.

Five-bearded Rockling.

Bass.


Sardine, or Pilchard.

Whitebait.

Herring.

Sprat.

The true Flounders have most of the teeth on the blind side. The Common, or Winter, Flounder is next in importance to the halibut. It ranges the Atlantic as far south as the Carolinas. The Great, or Starry, Flounder is the important Pacific species. There are several others. We have only one of the true Turbots, a small fish, which is closely related to the European Turbot.

Belonging to one or another of these groups are many smaller flatfish, but their names are very confusing. The true Plaice is European, but the name is used in America for several slightly different fish. The Brill is European. Several different fish are called Dabs both in Europe and America. The true Sole belongs to a closely related family and is not found in American waters, but with us several flounders are called Soles.

Now we come to one of the most important families of all, the Cod, which includes pollacks, true cods, tomcods, haddocks, hakes, whitings, lings and burbots. The two last-named live in fresh water, but the family generally inhabits the northern seas of the world. About 140 species are recognized, but only a few are important.

The Common Pollack is found on both sides of the Atlantic as far south as New York and France. It is seldom more than three feet long and is excellent food, though it destroys many other fish. The Alaska Pollack is the common Pacific form. The Tomcod is a miniature cod which is seldom more than a foot in length, and its habits are similar. There is an Atlantic and a Pacific species.

The Common Cod is found over the North Atlantic, and some students think that the Alaska Cod is the same fish and not a separate species. Search for the cod has trained some of the hardiest seamen in history. In fact, the men trained on the fishing-banks of Newfoundland formed a considerable part of the force which defeated the Spanish Armada. The fisherman of to-day is equally hardy. You will find in Kipling's stirring story Captains Courageous a thrilling account of their lives.

The Cod eats everything—birds, fish, crustaceans, molluscs and vegetation. It swallows the molluscs whole, and many rare shells were first found in the stomachs of cod. Other queer things have been found in the stomachs of cod, such as scissors, a boot-heel, an oil-can, corncobs, and even finger-rings.

Though cod over six feet long and weighing over two hundred pounds have been caught, such large specimens are very rare, but specimens weighing up to fifty pounds are not uncommon. A large female may lay up to ten million eggs, which rise to the surface and float on the water. If any considerable proportion hatched and grew up, the sea would soon be packed full of cod.

As a matter of fact, so many are eaten by other fish and by birds, and so many wash up on the shore, that it has been feared that the cod would become scarce. Fortunately the eggs are easily collected, and the United States Fish Commission has set free hundreds of millions of young cod. While most of these were probably eaten by other fish, it is certain that many do escape the many enemies of their youth. The cod is often eaten fresh, but more often is dried and salted. From the liver an oil is obtained which has a great reputation as a remedy in tuberculosis and other wasting diseases. It and the oil from halibut livers are both rich in vitamins.

The Haddock is smaller than the cod and feeds largely on molluscs. It is abundant on both sides of the North Atlantic and is often smoked. Some of you know "finnan haddie," which is haddock used in the manner of the village of Findon, in Scotland. Fish of two different families are called Hake. One belongs to the Cod Family and the other resembles a cod. We have both. The name Ling is also applied to the former. The European Ling is a salt-water fish of the Cod Family, and to add to this confusion in common names, we usually call a member of the family which lives in some of the lakes of Canada and the United States by this name. It is almost, if not quite, the same fish as the European Burbot. Other names are Lake Lawyer in this country and Eel-pout in England.

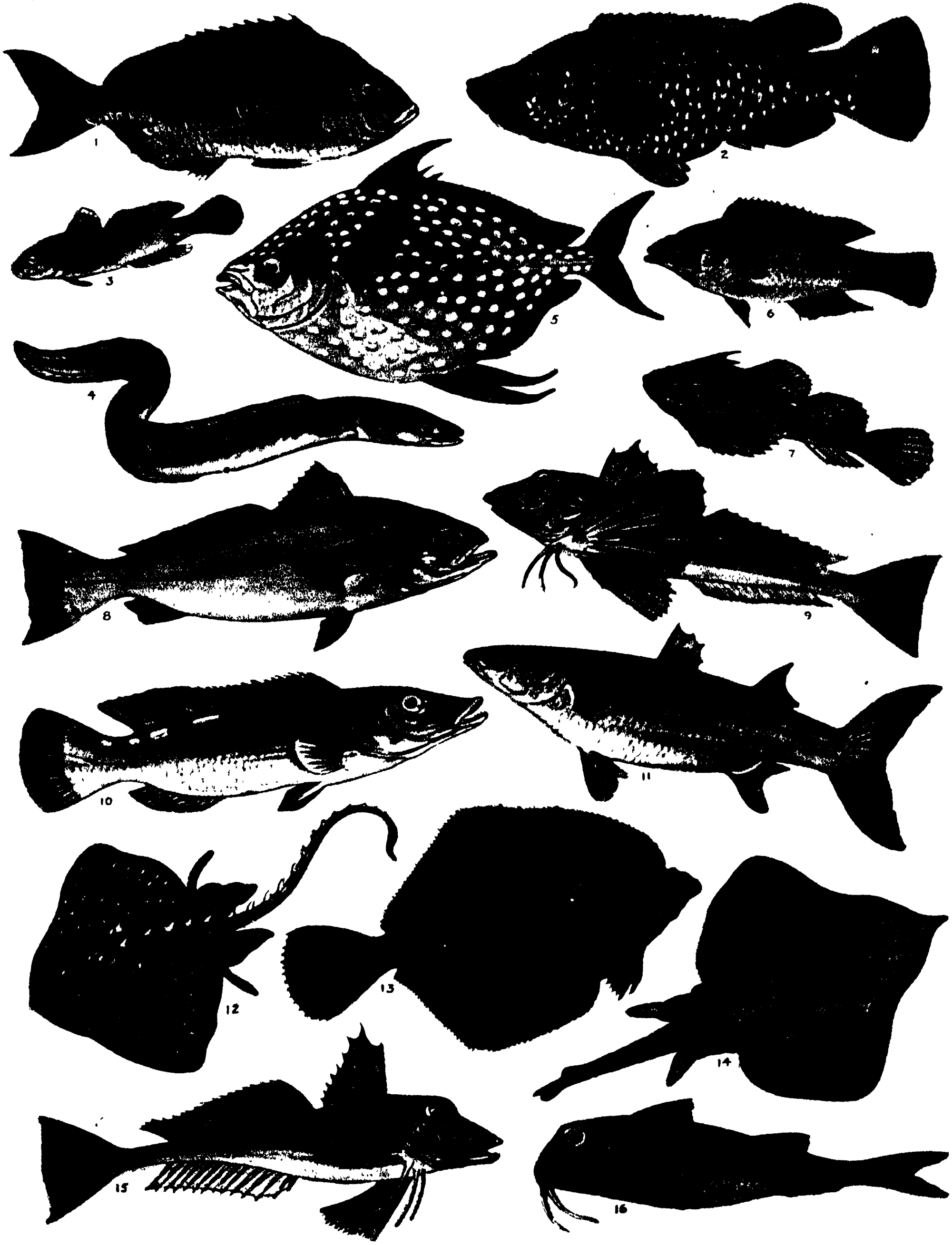
There are many other fishes we should like to mention. There is the Pompano, found only in southern waters, which some think is the best of food fishes. The large Snapper Family is also confined to the southern waters of the world. America has about twenty species, generally bright in color, and all good to eat. The Red Snapper is often seen in city markets. The Porgy Family is another group of southern fishes, though a few do wander northward. The Scups and the Sheepheads belong to this family. They are good food fish.

Several members of the Croaker Family range as far north as the Bay of Fundy. The Common Weakfish, also called Squeteague and Sea Trout, is the best of the family; except perhaps the California White Sea Bass, which is found as far north as Vancouver. The Croaker proper is common along the Atlantic coast. The Kingfishes, also of this family, are generally called Whitings, but the true Whiting is a European fish of the Cod Family.

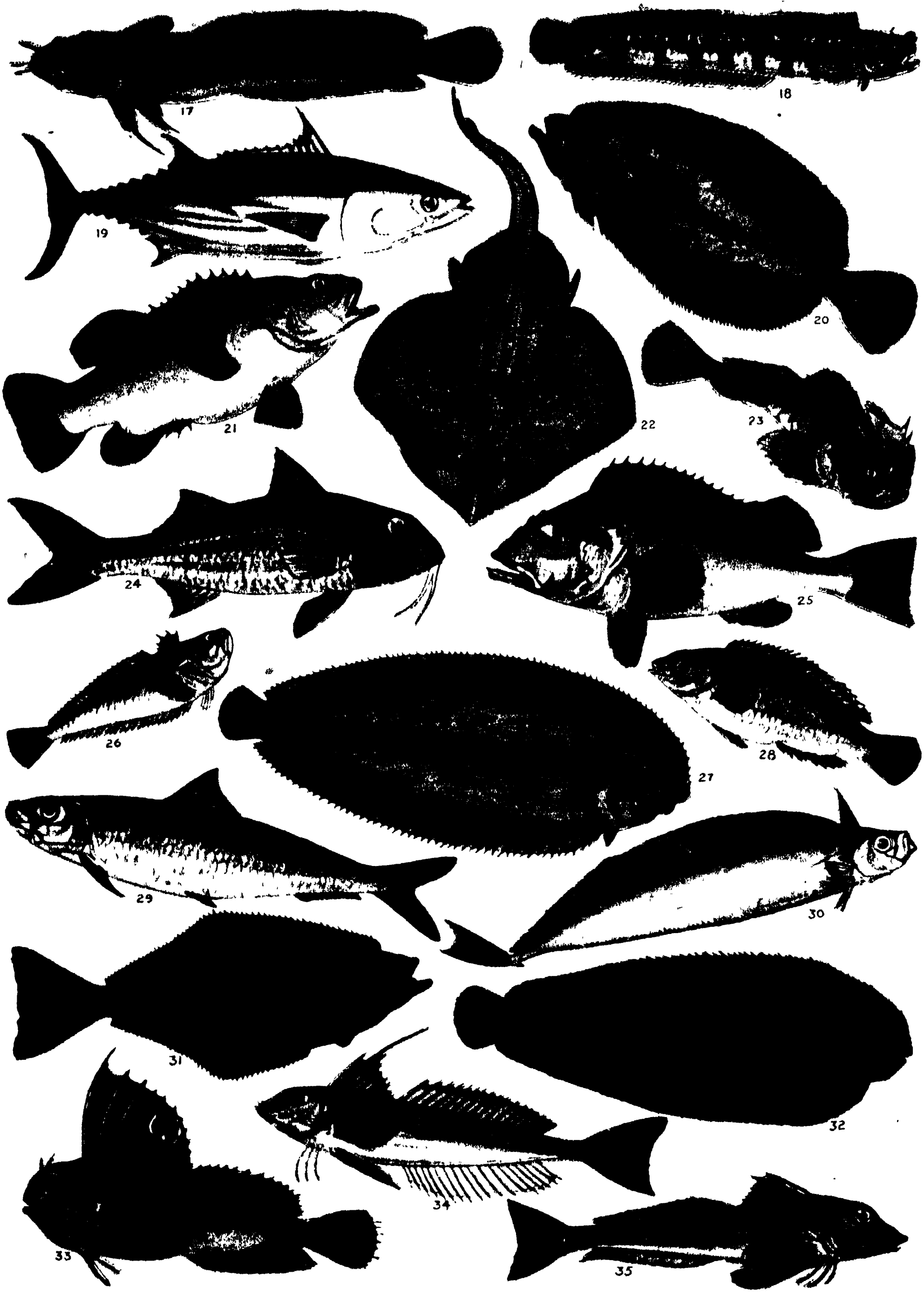
About 12,000 species of fishes are known, and over 3,300 of them live in American waters north of the Panama Canal. Two distinguished scientists, Jordan and Evermann, tell of American fishes only in a work of four volumes and over 3,300 pages; so you see that if we are to tell you of other things, we cannot tell you of all the fishes.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5893.

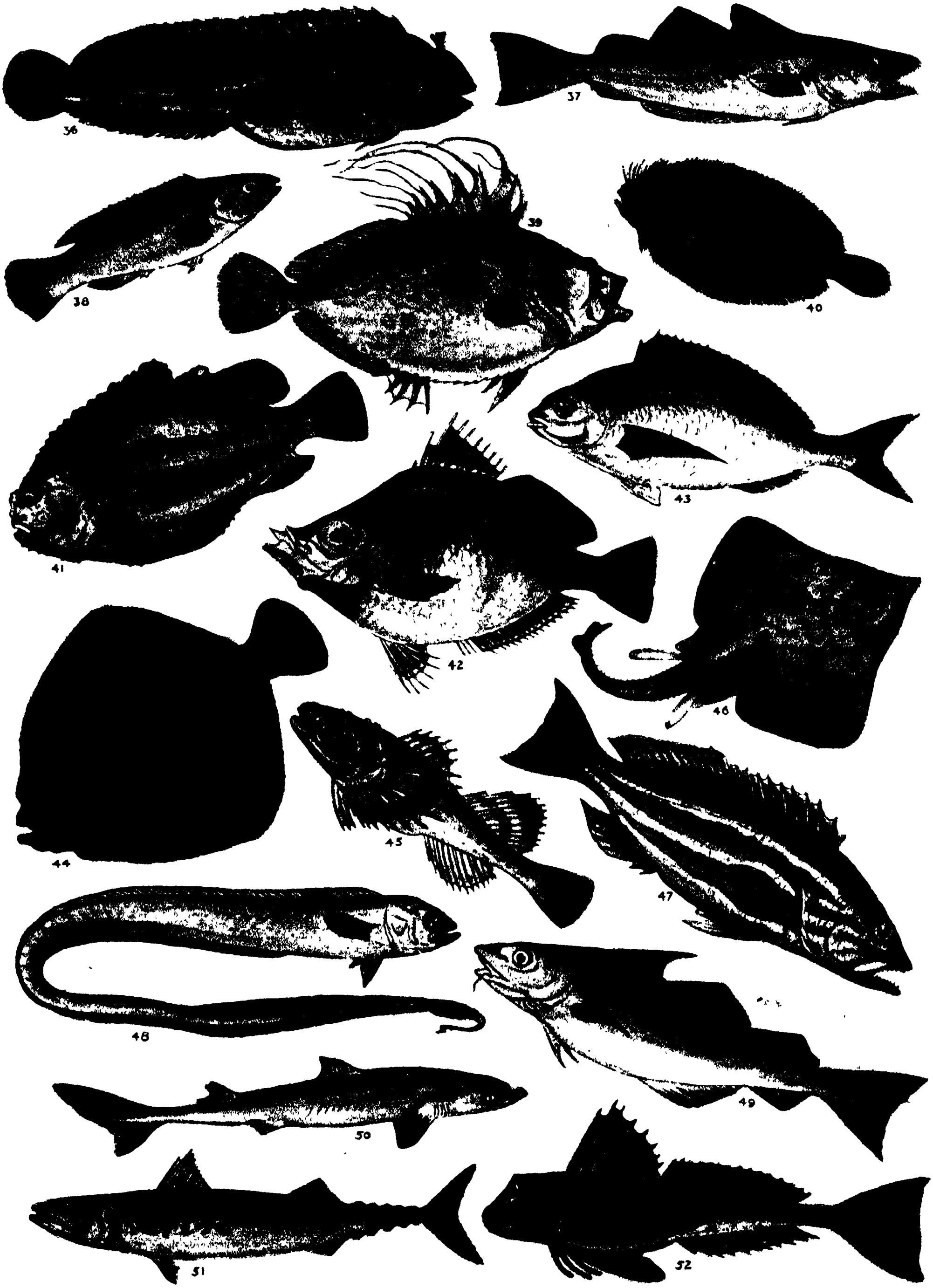
FISHES OF THE NORTH ATLANTIC



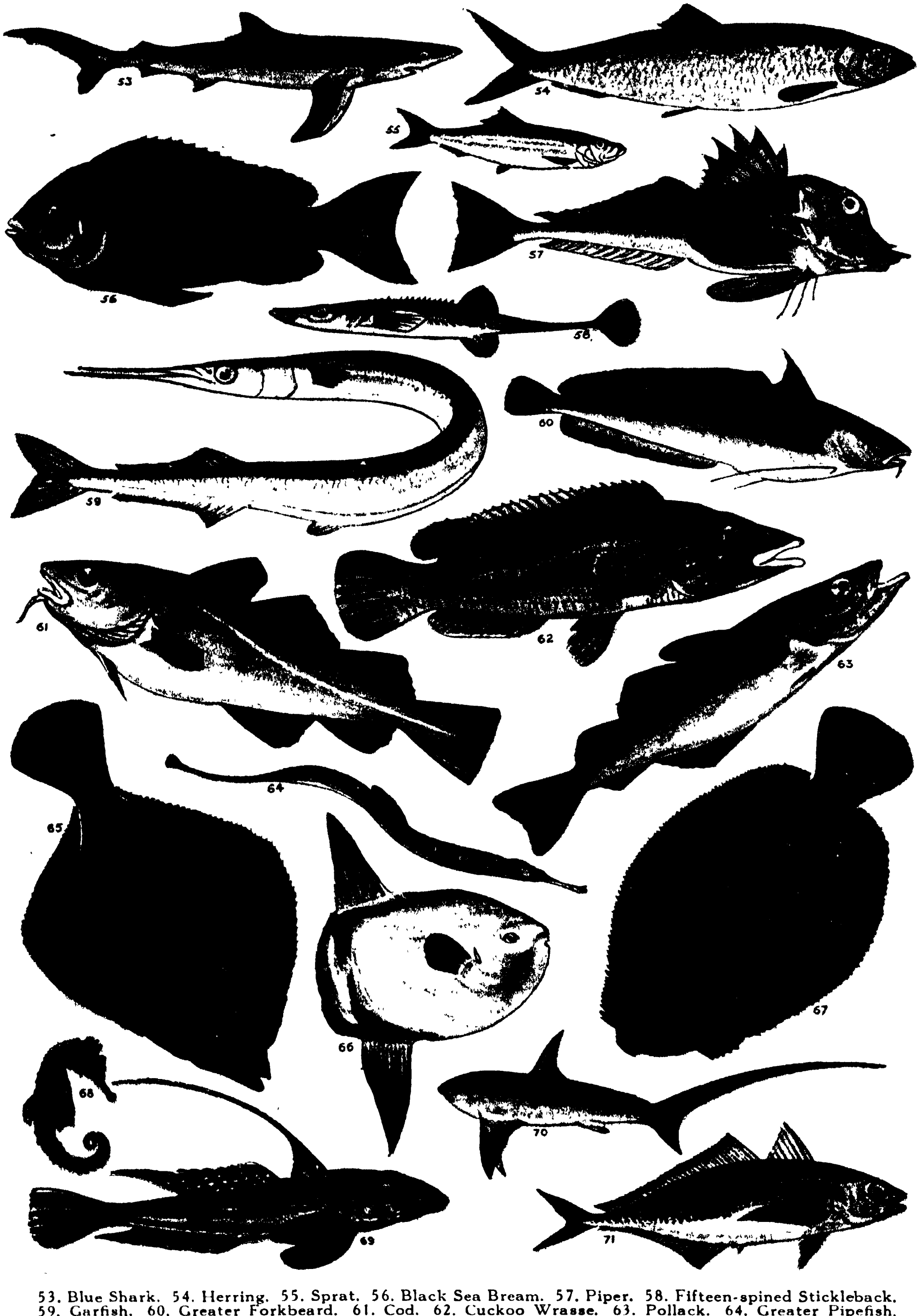
1. Becker. 2. Ballan Wrasse. 3. Paganellus. 4. Conger. 5. Opah. 6. Corkwing. 7. Bubalis.
8. Sciæna. 9. Tubfish. 10. Three-spotted Wrasse. 11. Gray Mullet. 12. Starry Ray. 13. Plaice.
14. Shagreen Ray. 15. Elleck. 16. Red-Mullet.



17. Three-beard Rockling. 18. Yarrell's Blenny. 19. Bonito. 20. Carter. 21. Stone Bass.
22. Cuckoo Ray. 23. Father-lasher. 24. Surmullet. 25. Bergylt. 26. Viper Weever.
27. Lemon Sole. 28. Rock Cook. 29. Pilchard. 30. Dealfish. 31. Halibut. 32. Sole
33. Butterfly Blenny. 34. Lanthorn Gurnard. 35. Gray Gurnard.

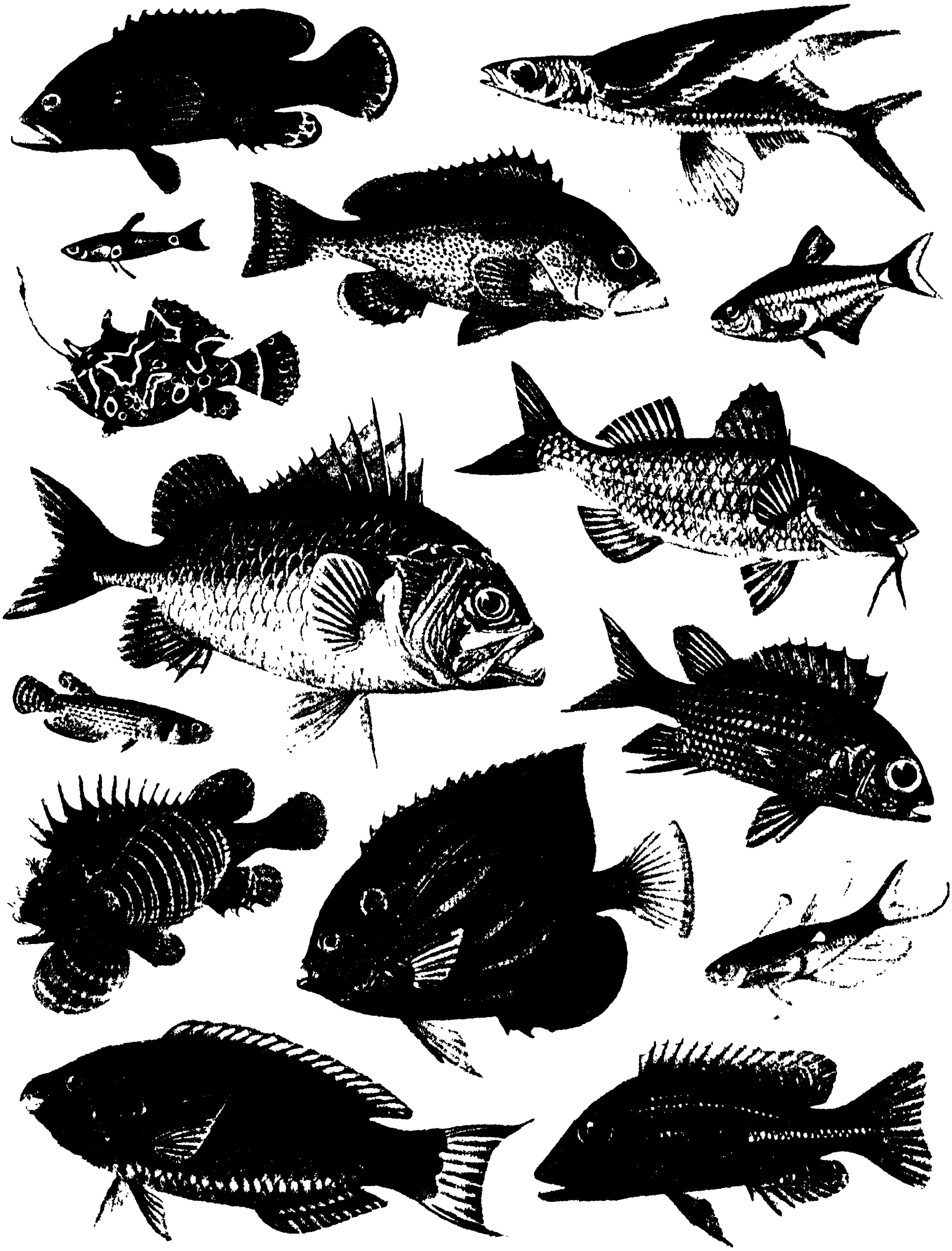


36. Tompot. 37. Whiting. 38. Jago's Goldsinny. 39. Dory. 40. Scaldfish. 41. Lumpfish. 42. Boarfish. 43. Sea Bream. 44. Turbot. 45. Four-horned Cottus. 46. Skate. 47. Comber. 48. Red Bandfish. 49. Haddock. 50. Common Dogfish. 51. Mackerel. 52. Streaked Gurnard.

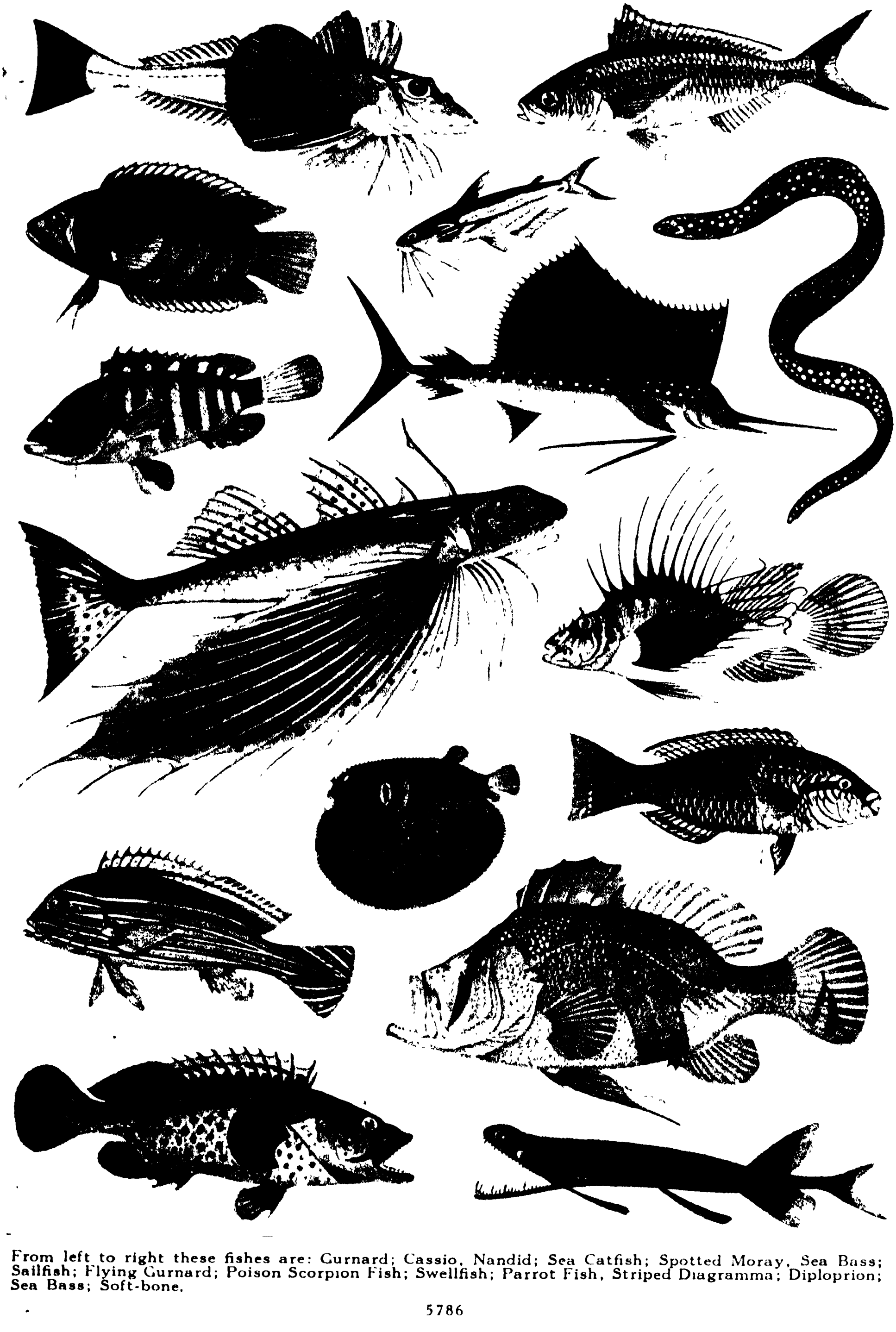


53. Blue Shark. 54. Herring. 55. Sprat. 56. Black Sea Bream. 57. Piper. 58. Fifteen-spined Stickleback. 59. Garfish. 60. Greater Forkbeard. 61. Cod. 62. Cuckoo Wrasse. 63. Pollack. 64. Greater Pipefish. 65. Flounder. 66. Sunfish. 67. Brill. 68. Sea-horse. 69. Yellow Skulpin. 70. Fox Shark. 71. Scad.

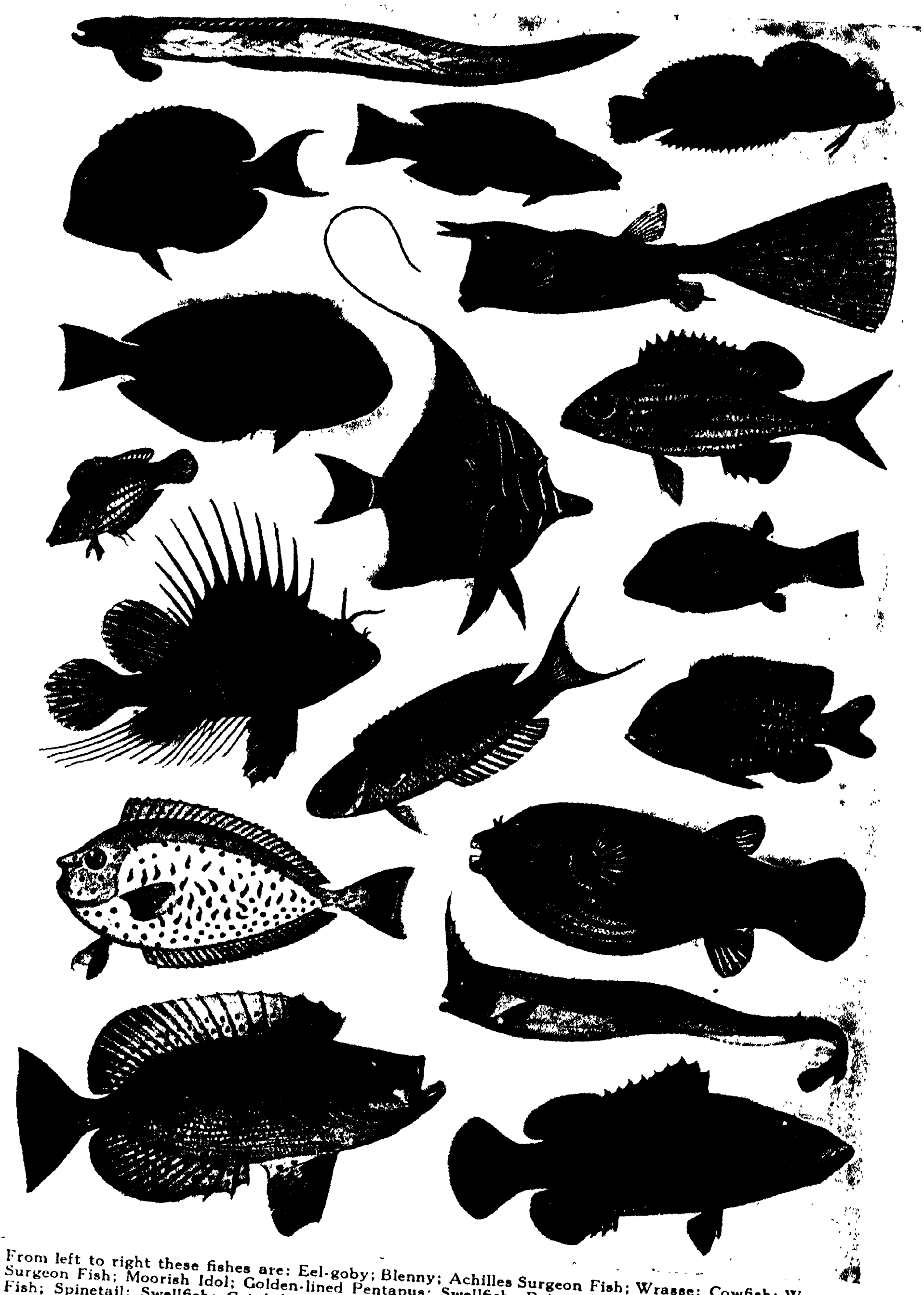
FISHES CHIEFLY OF THE WARMER SEAS



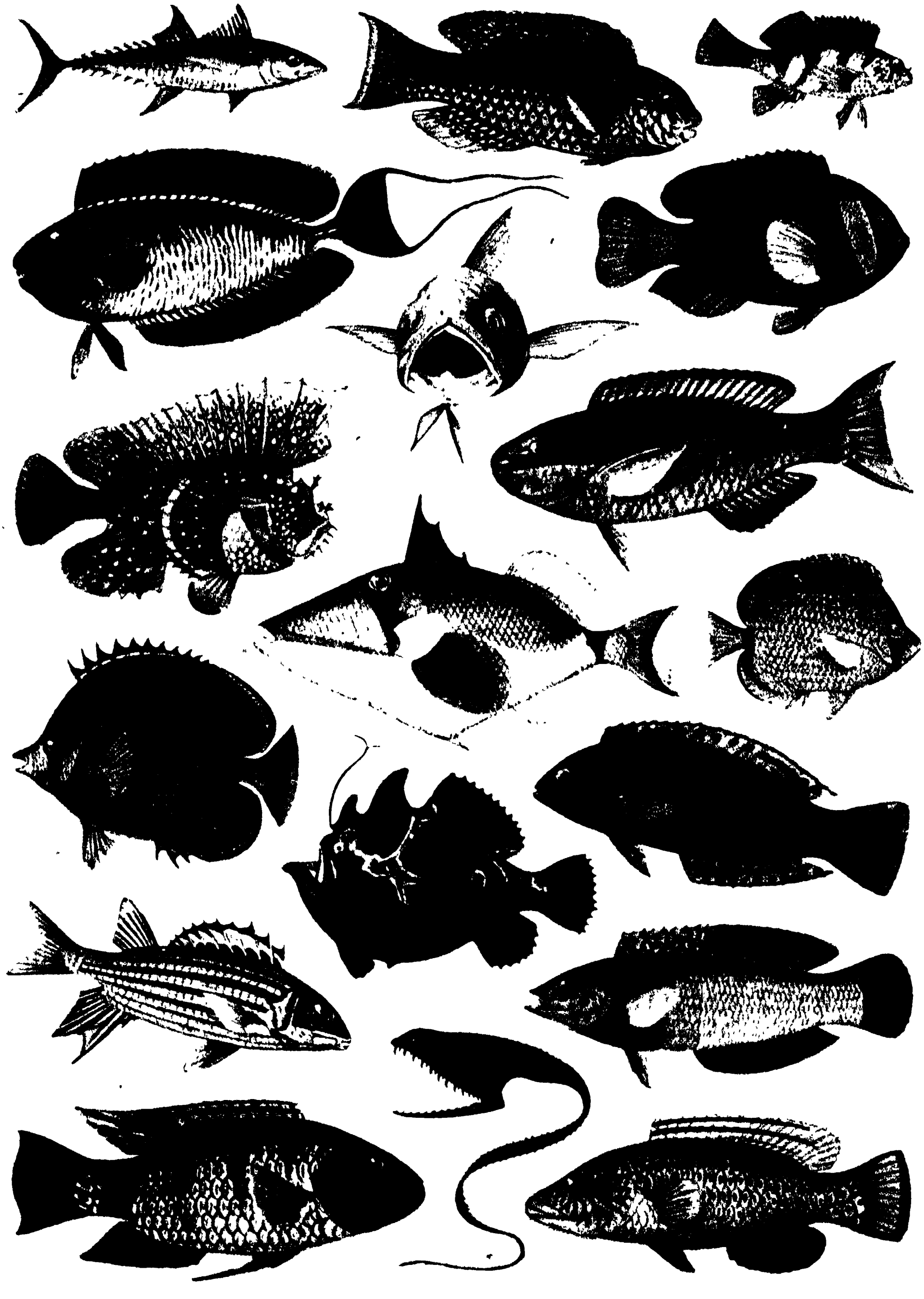
Most of these fishes belong to tropical waters, though specimens occasionally venture northward and a few northern species are represented. From left to right they are: Sea Bass; Four-winged Flying Fish; Guppy; Sea Bass; Characin; Frogfish; Deep-water Squirrel Fish; Goatfish; Rivulus, Squirrel Fish; Poison Scorpion Fish; Ringed Angel Fish; Characin (Stevardia); Parrot Fish; Porgy.



From left to right these fishes are: Gurnard; Cassio, Nandid; Sea Catfish; Spotted Moray, Sea Bass; Sailfish; Flying Gurnard; Poison Scorpion Fish; Swellfish; Parrot Fish, Striped Diagramma; Diploprion; Sea Bass; Soft-bone.



From left to right these fishes are: Eel-goby; Blenny; Achilles Surgeon Fish; Wrasse; Cowfish; Wrasse; Surgeon Fish; Moorish Idol; Golden-lined Pentapus; Swellfish; Poison Scorpion Fish; Wrasse; Damsel Fish; Spinetail; Swellfish; Catalufa; Oarfish; Japanese Sea Bass.



From left to right these fishes are. Mackerel; Wrasse, Banded Cirrhitid, Spinetail; Unidentified; Damsel Fish, Crested Scorpion Fish; Parrot Fish; Butterfly Fish, Trigger Fish, Butterfly Fish; Red Frogfish, Wrasse, Red-and-white Squirrel Fish, Black Gulper; Wrasse; Parrot Fish; Wrasse.

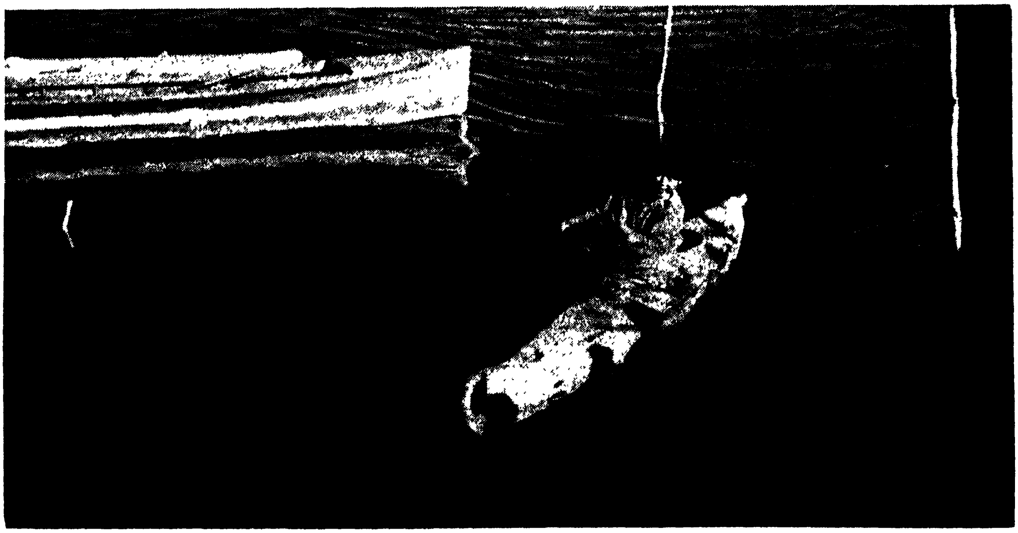
THE STORY OF ALASKA

THE story of Alaska really begins with the days of Peter the Great of Russia. It was a time of great excitement throughout Europe, for Guillaume de Lisele, First Geographer to the King of France, had just given to the world a new map that showed a great unexplored country between Asia and America. It was reported that this land was one of fabulous wealth, a veritable Eldorado. France and Spain at once sent ships sailing over the seas to explore and claim the new country for their respective sovereigns.

Wonderful tales of the northwestern land drifted to the ears of Peter, tsar of Russia, and he, too, resolved to add it to his empire. He planned an expedition in charge of Vitus Bering, a Danish navigator in his service. Peter died before Bering could set sail, but Peter's wishes were obeyed, and the expedition went forth in high hopes. It failed so completely that Bering returned to Russia convinced that "though there was such a country on the maps, there was none in the sea." But the Russians would not listen to Bering but sent him out again and again.

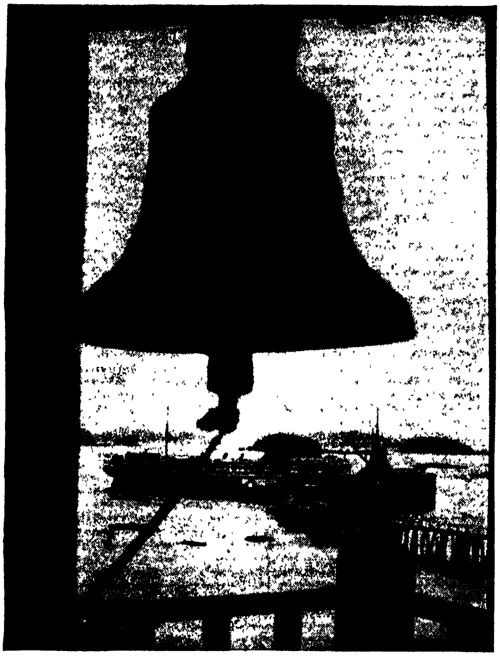
In 1741 Bering sailed once more. For days at a time he was enveloped in an impenetrable fog, and at last he gave up hope and ordered his ship to turn its head homeward. As he did so, behold, the fog lifted! Driftwood and seaweed and birds appeared, and before them lay a great land, and a high peak raised its giant head into the clouds. Because it was St. Elias' day they called the peak Mount St. Elias. Bering's two ships were separated by storm. He himself became so ill with scurvy, the sailors' scourge, that he could not command his ship. He made a landing on an island in the sea that now bears his name, and died there. His expedition found its way back to Russia, in great discouragement, and no white settlement in Alaska was made for more than forty years afterward. The remnant of the Bering expedition, however, had brought back some fine rich furs, and so the thought of Alaska as a possible source of wealth, at least from the fur-bearing animals of the country, remained alive.

In 1777 Captain James Cook, the English mariner, sailed along the western coast of North America trying to find a northern passage between the Atlantic and Pacific oceans. He went as far as Icy Cape (which he named) in the Arctic Ocean. On the



U. S. Dept. of the Interior

An Eskimo of Alaska in a kayak, a one-man, covered canoe that is usually made of sealskin.



The bell of the old Russian Cathedral of St. Michael, at Sitka, once capital of Russian America.

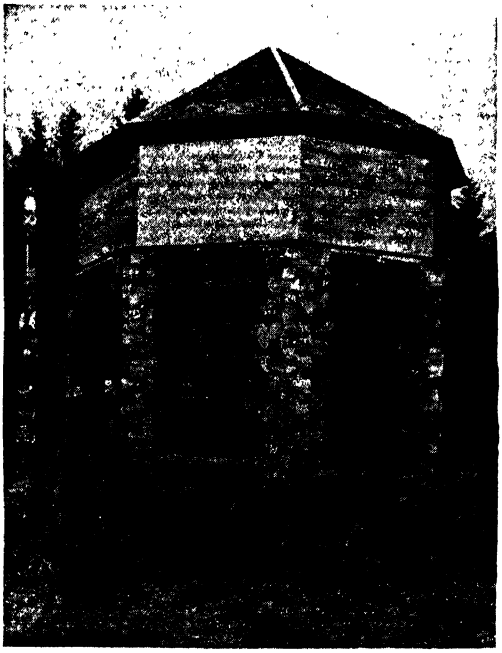
Aleutian Islands he found a few scattered Russian settlers. From 1790 on, trading monopolies controlled the area, which was called Russian America. They established posts at Kodiak, Sitka and other points, and sent priests to organize missions and open schools. However, these settlements were on the southern islands and along the coast. The great interior of the mainland was practically unexplored, a vast region of mystery.

The land seemed bleak and bare, with but few natural resources. A few fur-traders wandered over the waste, and Sitka was for a while a considerable town, but furs became scarcer. Finally Russia needed money, and in 1867 sold this great tract of wilderness to the United States for the sum of $7,200,000. This purchase caused a great deal of excitement, and it was the general verdict throughout North America that the Government of the United States had done a very foolish thing. It seemed sheer "wasteful extravagance to pay $7,000,000 for miles of icebergs and polar bears."

For a time the country was occupied by United States soldiers, but there was nothing for them to do, and a naval officer governed the country. He was withdrawn, and for years there was no government at all, except for tribal customs of the Eskimos and Indians, who were thinly scattered over the land. In 1884 Congress gave the president power to appoint a governor, but did not trouble to make laws for the country. The laws of Oregon were declared to be in force so far as they were suitable.

It was known that there was gold in Alaska, but not much attention was paid to the fact, though in 1895 hundreds of men were engaged in mining, and one or two of the mines produced large quantities of the precious metal. In 1896 rich placer deposits were discovered in the Klondike, near the boundary, but on the Canadian side of the line. A placer is a deposit containing gold in the sandy bottom of a river. Scattered free in the soil, the gold has been washed along with the soil into the stream, where it sinks to the bottom and remains. No expensive machinery is required to get it out: a man simply uses a pan to wash the gold out of the soil. This process is known as placer mining.

Thousands rushed to the Klondike and swarmed over on the American side, but not much gold was found until 1899. Then even richer deposits were found around



Pictures, courtesy, Alaska Steamship Co.

A replica of an old Russian blockhouse, now to be seen in the Sitka National Monument.

Nome, on the western coast. Many other fields were discovered, and every boat that could float carried eager seekers for gold to the North. Some men were very successful. As the result of a single week's work a man might get thousands of dollars. Men went mad fighting for claims that showed good prospects, but some found no gold at all. Deep mines were opened, and more and more of the gold comes from them. From 1896 to the present, Alaska has produced over $500,000,000 of gold, much of it from placer mines.

Gold is found in almost every corner of Alaska, but the individual owners are losing their grasp, and the mountains and rivers are being worked by large corporations with ample capital to install expensive machinery. "The day of bucket and windlass has passed for the Klondike. Dredging and hydraulicking have taken their place, and the trains and steamers are loaded with powerful machinery to be operated by vast corporations."

Gold is not the only mineral found in Alaska. Copper-mining began in 1901, and since that time other deposits have been found. While not so large as the production in some other regions, the amount of copper produced is large.

There are vast fields of coal in Alaska, but they have not been worked very much. Some of the coal is good, but much is rather low grade. Coal is so heavy in proportion to its value that the coal-fields will not be worked until more railroads are built so that it can be moved more cheaply.

Tin is found, and there is some petroleum, though how much is not known. Some good marble is found, and some gypsum also. Small quantities of other minerals have been found. The truth is that the country has never been really explored, and we do not yet know how valuable the minerals are. Some men think that some day Alaska will be one of the chief mining districts of the world.

Agriculture, too, has been found to be very profitable in the southeastern portion of Alaska. Potatoes, cabbages, turnips, cauliflowers, beets and other vegetables grow to an enormous size in the short Alaskan summer. Like mushrooms, they seem verily to spring up overnight. It is one of the wonderful things of this northland that wild currants, blueberries, raspberries and luscious strawberries can be found growing in sheltered nooks under the very shadows of the glaciers, though some complain that they are too watery.

There are no large farms, for labor is very expensive, and many kinds of food can be brought from the United States more cheaply than they are raised, but the excellent market for fruits and vegetables makes market

Courtesy, Alaska Steamship Co.

The valiant husky dog is still used for transportation in the interior of Alaska during the winter. These dogs, sometimes called Labrador huskies, are usually hitched to the Labrador harness. That is, seven to nine dogs are hitched, each by a separate trace so that they fan out over the snow.

Courtesy, Alaska Steamship Co.

An "old timer" lone prospector still hopes that he will find gold in one of Alaska's streams. He washes the sand and gravel to separate from it any bits of gold that it may contain.

gardening very profitable. Some of the land produces excellent grass, and cattle and sheep are being raised. As the population increases, the amount of land cultivated will increase also. The United States in 1936, began to assist farmers to make homes in Alaska. Some are succeeding.

There is much timber in Alaska. Hemlock, spruce and cedar are very common in some parts, and there are also poplar, aspen and birch. In some parts the trees do not grow large, but there are thousands of acres which can be used for paper-making. Some of the plains are treeless, but everywhere the wild flowers are many and beautiful.

Many excellent food fish are found in Alaskan waters. The salmon is most important, and there are dozens of canneries which preserve the fish for export to all parts of the world. Several kinds are found in countless numbers, and some of them are smoked and dried instead of being placed in cans. Cod, halibut and herring are also caught. Though the whale is not a fish, we often speak of the whaling industry along with fishing. Men have hunted for whales around Alaska for a long time, but not so many are caught now as in former years.

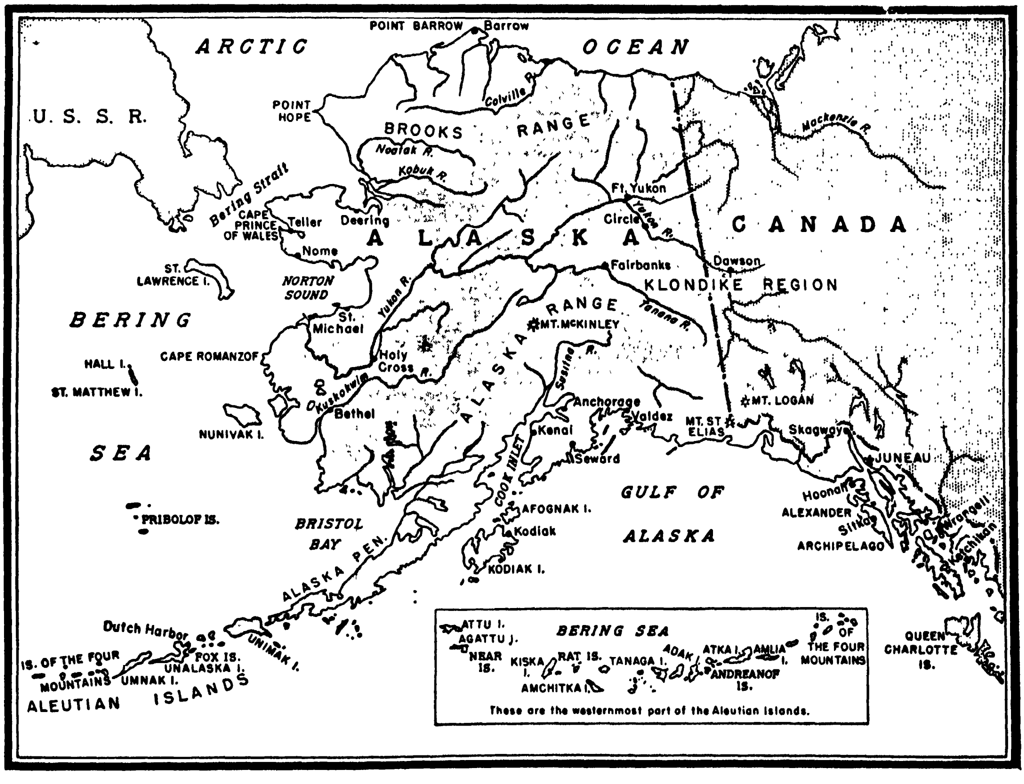
Once the sea-otter was common, but now it has almost disappeared. Thousands of seals once covered the islands, but they were hunted so vigorously that by 1910 they, too, seemed doomed. The United States Government took charge of their haunts on the Pribilof Islands and restricted their killing. They have now increased in numbers, and sealskins are again plentiful in fur shops.

Sand-otters, beavers, ermines, minks, bears, foxes, lynxes and other fur-bearing animals are found, but the Government allows them to be killed only at certain seasons of the year. Through these rules it is hoped that the animals will increase in number and that Alaska will continue to be able to furnish warm furs. There are many fur farms.

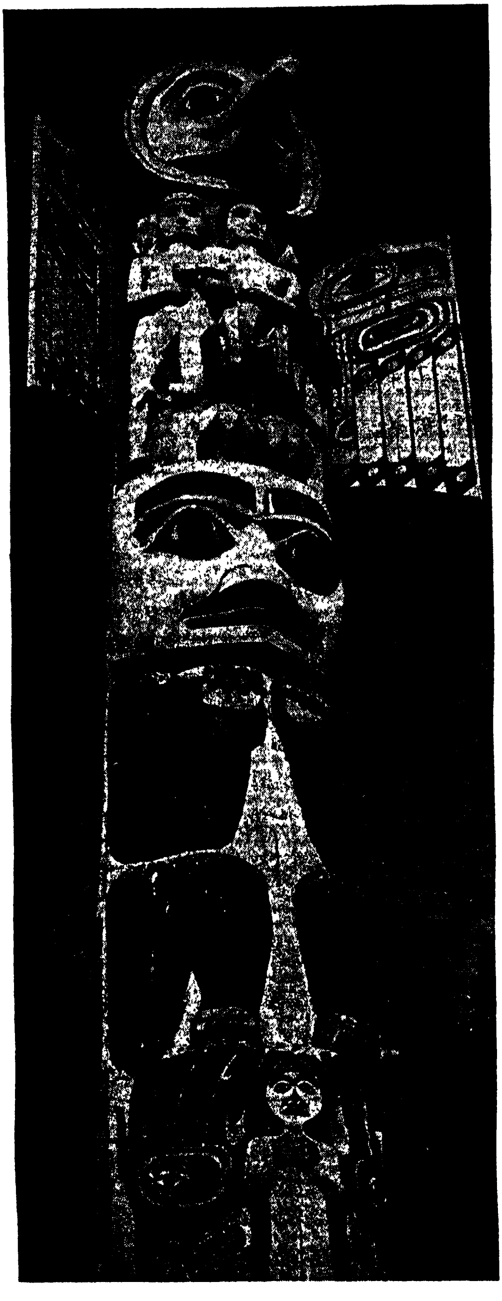
The native inhabitants of Alaska are Eskimos and Indians. Most of them make their living by fishing and hunting. Sometimes game was scarce and they suffered from hunger. They had no domestic animals except dogs, which were used in hunting and to draw their sledges. Some wise men thought that the condition of the natives would be improved if they had a regular source of food, and in 1892 the Government began to bring in reindeer from Siberia. They were sold or loaned to the natives, who were taught to care for them. They have increased in numbers so rapidly that now they are regularly killed for food. Many of the natives have herds of them and are growing prosperous. Reindeer flesh is good for food, the skins for clothing, and the animals are trained to pull sledges.

At the same time the population is very small. At the census of 1940 there were only 72,524 people, including whites, Indians and Eskimos and others in a territory almost one-fifth as large as the United States. It is plain that such a small population cannot build the railroads needed, but fortunately the airplane has come to the rescue. In addition to major air lines of the United States and Canada that serve Alaska, there are many privately owned lines in the territory, which carry passengers and goods on long and short hauls. Much of the mail is carried by air. The Alaska Railway, owned by the Government, has a number of branches running to towns in the central part of the territory. This railroad, including branches, is more than 500 miles long. The White Pass and Yukon is another railroad. A network of highways connects with the great Alaska Highway, which was built during the second World War.

The rivers and lakes of Alaska also make fine highways, both in the winter, when they are frozen, and in the summer, when boats of many sizes and types ply busily between port towns. About 8,000 miles of sled roads and trails crisscross the interior, for sled dogs and a few reindeer are still largely used for transportation. A good dog in Alaska may cost as much as $20. The thick-furred, long-legged "Labrador huskies" are the most powerful as well as the most valuable. A load of 150 pounds per dog is the usual burden, and seven to nine dogs are attached, each by a separate trace. The Labrador harness is used with them so the dogs spread out fan-shaped from the sledge and do not interfere with each other. The "malemutes," or native Indian dogs, usually half wolf, are driven and harnessed differently—all in a line and one before the other. The malemute is the king of all thieves. He will pull the leather boots off your feet while you sleep and eat them for a midnight supper, and he delights to eat up his seal-hide harness. He has learned to open a wooden box and will devour canned food, opening any tin can made, with his sharp fangs, quicker than any steel can-opener. Once a day only they are fed on raw fish, and while the malemute prefers to pilfer, the husky will go and fish for himself when off duty. Seventy miles a day is the rule with the Indians and their dog teams.



As this map shows, the great Yukon River crosses Alaska almost in the center; and in the southern half is the highest peak of North America, Mt. McKinley. A thin arm of the peninsula, the Aleutian Islands, stretches far out into the Pacific; while the Alexander Archipelago nestles close to the mainland.



Courtesy, Roeder, Alaska Steamship Co.

The most striking of the Alaska Indian's ancient relics are the totem poles. These weirdly carved, strangely colored reminders of a by-gone day are still to be seen near Ketchikan, Wrangell and Sitka. They are the "family trees" of certain American Indian tribes. Each family's pole contained pictures of its totems which were animals or other objects held sacred by the tribe.

The dog-driver carries a club and seal-hide whip, both of which he uses unmercifully, for the dogs are very fierce and delight in fighting. A fight among these fierce, half-tamed dogs of the North is not like the fights we see among our own. They fight wolf fashion—strike and leap away, strike and leap away—and the fight is to the death. Each dog knows this law and fights with a horrible intentness. Leap and slash, they fight—until lips and heads and bodies are gashed and bleeding. Around the combatants sits a staring circle of huskies. When either dog shows signs of losing his feet they stand up eagerly; and when at last the defeated dog goes down, they close in snarling and yelping, and the dog, screaming with agony, disappears underneath a heaving mass of bodies. There is no mercy shown among the creatures of this wild land. The toil of the traces seems the supreme expression of their being. Men wise in the ways of the wild will tell you that sick dogs have been known to die of a broken heart when cut out of the traces.

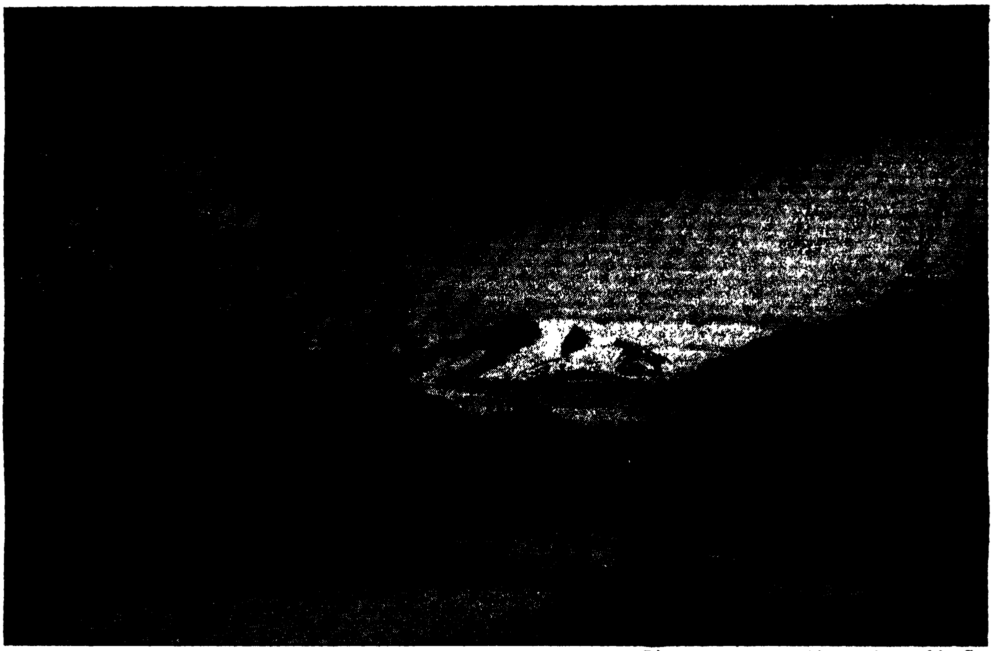
Alaska is a wonderful country, and will be visited by more and more tourists as its marvels become better known. It has high mountains, great glaciers, deep forests, beautiful fields, wonderful flowers and interesting animals. Some volcanoes are still alive, among them the noted Mount Katmai, which, with the valley of 10,000 smokes, has been made a national monument. On June 6, 1912, Katmai erupted with such violence that it blew its head off. This was one of the greatest volcanic upheavals known in history. It is thought that among the Alaskan mountains at least twenty other peaks are active.

There is a great difference in climate in the interior and on the coast. In the interior a temperature of 60° below zero in winter is not unusual. On the coast the thermometer rarely falls below zero.

In all the vast area of Alaska there are too few people to subdue the land. When the last census was taken there were five white men for every white woman in the territory. Some day, when the railroads are built, the tide will turn toward this great territory so full of riches of many kinds. Many places in Europe which are quite as far north are inhabited by large populations. Norway, Sweden and Finland are in about the same latitude. There is no reason why Alaska cannot support hundreds of thousands of settlers. Perhaps the day is not far when such numbers shall live there.

NEAR THE OLD AND THE NEW CAPITALS

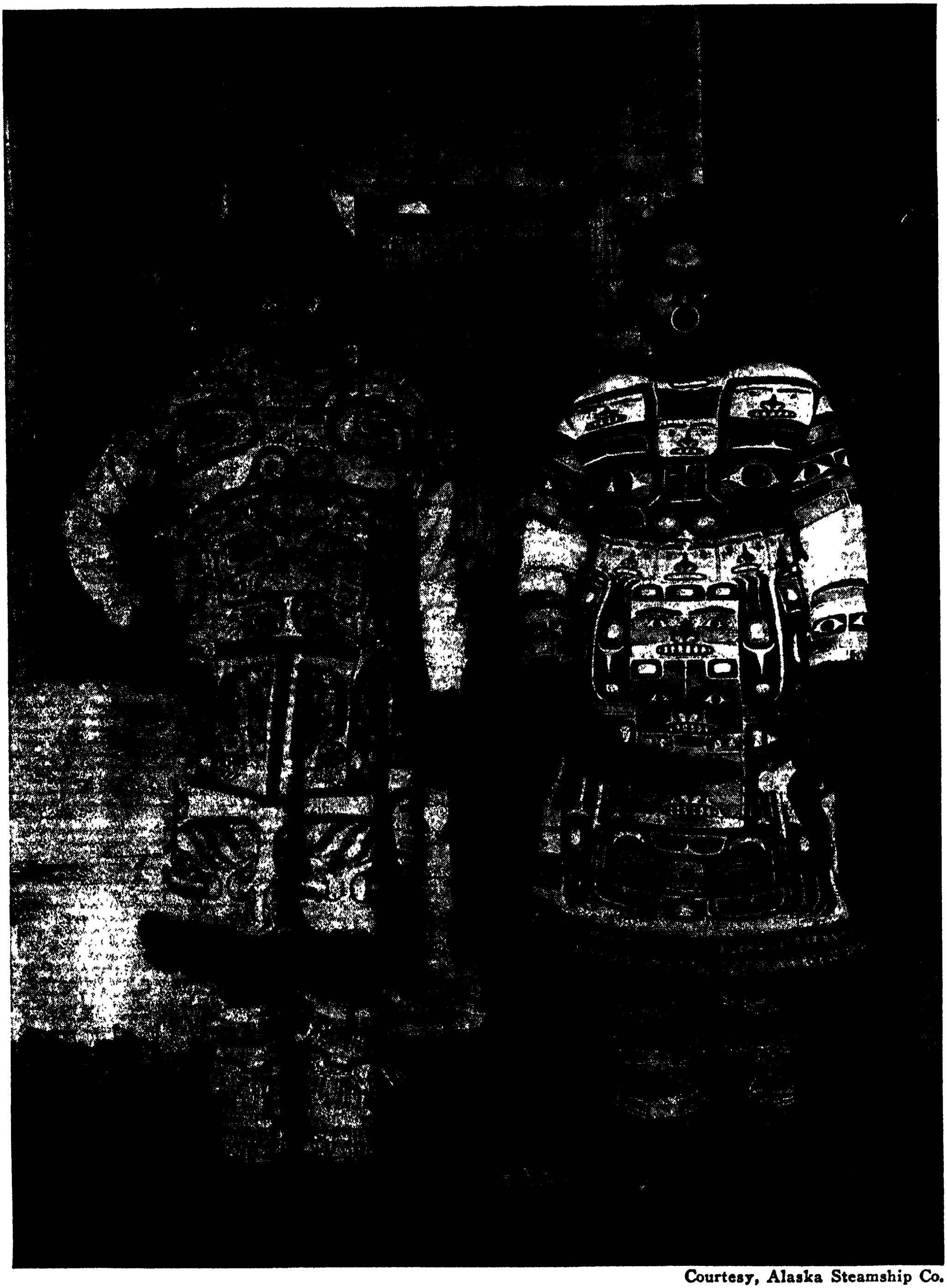
Sitka, shown here against its background of mountains and water, was the capital of Russian America, before Alaska was purchased by the United States; then it was the headquarters of the United States authorities.



Pictures, courtesy Alaska Steamship Co.

Auk Lake and Mendenhall Glacier, near Juneau, the present capital. The most extensive remnants of the ice age in America are found in this region. Live glaciers are those which reach the sea.

INDIAN DRESS WITH TOTEM DESIGNS



Courtesy, Alaska Steamship Co.

These Chilkat Indians of the Alaskan Panhandle are dressed up in their ceremonial robes, which have strange designs, not unlike those on the totem pole on page 5794. The natives of Alaska consist of Eskimos and several tribes of Indians. They are aided by the Government in several ways, under the Office of Indian Affairs.

SCIENCE

RADIOACTIVE ELEMENTS

THE STORY OF SELF-SMASHING ATOMS

LOOK at the table of elements on page 313. Draw an imaginary line above lead, atomic number 82. The part of the table below the line we may consider to be a corner of Nature's laboratory, where many fascinating things are going on, including atom-smashing on a grand scale.

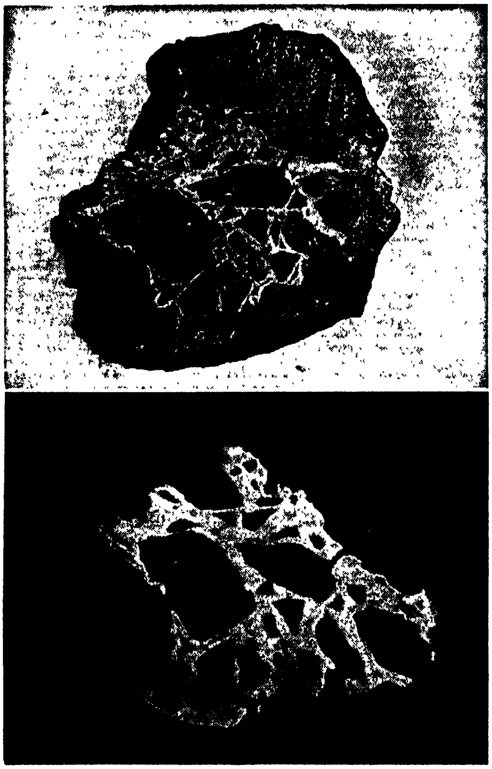
All of the elements in this group take part in atom-smashing to some extent. Several of them—astatine, francium, neptunium, plutonium, americium and curium—are man-made. Of those found in nature, the ones that take the most active part in atom-smashing are: polonium (84), radon (86), radium (88), actinium (89), thorium (90), protoactinium (91) and uranium (92). These elements send out strange rays that we can not see with our eyes. We call this sending out of rays radioactivity; and the study of radioactivity is a brilliant chapter in the story of science. Men and women living in many countries have a place in the story, each one contributing clues which all of them have drawn upon.

In 1895 Professor Wilhelm Konrad Röntgen, of Germany, discovered X rays—mysterious invisible rays which could pass through some substances but not through others, and make still others suddenly shine brightly.

They were called at first Röntgen rays, after the man who found them; but we know them better as X rays. X, in many languages, stands for something mysterious or unknown. Röntgen's discovery had taken the scientific world by the ears. Scientists everywhere were curious about the strange rays,

Courtesy, Canadian National Film Board

Children are shown chunks of radioactive uranium ore at the Eldorado mine, Great Bear Lake, Canada.



Courtesy, Canadian Department of Mines and Resources

An exposed photographic plate shows veins of pitchblende (bottom) which run in natural rock (top).

and groped for an explanation. They made all kinds of experiments in the hope of finding the solution to the riddle. Some thought that X-rays came from the glass of the X-ray tube, because the glass begins to shine at the point where the X-rays fall on it. Phosphorescence, we call this effect in science. Students tried to see if other materials that phosphoresce in the dark after being in ordinary light also give off X-rays.

One of the men who tried along these lines was Professor Henri Becquerel, of Paris. He did not have much luck until he tried a salt of the rare metal uranium. This he knew did phosphoresce brilliantly after being in ultra-violet light. First he let the light shine on some of this greenish looking salt; then he wrapped it tightly in black paper and put it on top of a photographic plate, with a thin sheet of silver in between. After leaving it this way for several hours he developed the plate and found black spots on it. The plate had been "exposed." In other words, the uranium salt must have sent out rays of some kind that had passed not only through the black paper, but also through the silver. Later he tried other uranium salts and even the metal itself, and found that all uranium materials sent out these same rays, even those materials that did not phosphoresce after being in light. As these new rays are given off in the dark, Becquerel knew that they were not X-rays. He also found out very soon that they did something to the air through which they passed, in much the same way that X-rays do. When the new rays were passed through the air near an electrified body, it would slowly lose its charge. This must mean that the air, which is normally a good insulator, was almost changed to a conductor by these rays; it let electricity pass through, or, as the scientists say, it became "ionized."

Ernest Rutherford, in England, made further studies on these rays and soon found that there were two kinds among the uranium rays. He called them alpha rays and beta rays, after the first two letters of the Greek alphabet. The alpha rays are stopped easily; that is, they will not pass through sheets of paper, but they do ionize the air very strongly. The beta rays can pass through sheets of iron and some other metals. Rutherford figured that it must have been the beta rays that blackened Becquerel's photographic plate, for there they had to pass through both silver and paper.

Later, it was found that radioactive bodies send out still another kind of rays, still more penetrating than the beta rays. These were simply called gamma rays, after the third letter in the Greek alphabet.

RADIUM AND POLONIUM ARE DISCOVERED IN PITCHBLENDE BY MARIE AND PIERRE CURIE

Two earnest students worked with Becquerel in Paris. They were Pierre Curie, a French physicist, and his Polish wife, Marie Sklodowska Curie. These two examined a large number of ores and compounds of uranium and found one piece of rock to be very much more "active" than other uranium compounds. This came from the uranium mines at Joachimsthal in Bohemia, and was known as pitchblende, because it looks so black. They suspected that this ore might contain other elements even more radioactive than uranium. So they wanted to study the pitchblende very carefully. They were pretty sure that what they were looking for was in the ore in very, very small amounts, so they knew they would need hundreds of pounds of rock to investigate it. They were lucky enough to get, from the government of Austria, a whole ton of the waste material left over after the uranium had been taken out of the ore. After a long, heartbreakingly difficult job of examining the ore, and purifying it, and then purifying it again and again, they were finally able to set free from the mass two new radioactive elements.

The first of these Marie Curie named polonium in honor of her native country, Poland. The second one was called radium. Both of these substances are much more active than uranium. Radium when it is very pure is several million times stronger than uranium in sending out rays.

After the discovery of radium, progress was very fast; so many scientists began to work on radioactivity that discoveries followed each other in very quick succession. The knowledge gained in fifty years has been almost so amazing as to be beyond belief.

Before we can proceed with the story, let us briefly review our understanding of atoms.

No one has ever seen an atom, but scientists guess that the largest of them may be only one hundred millionth of an inch in size. Yet every atom is made up of still smaller particles. The most important particles are protons, electrons and neutrons. The proton weighs so little that if you counted the number of protons that make up half an ounce, you would need to write down a number with twenty-five zeros after it.

10,000,000,000,000,000,000,000,000!

The proton carries a small charge of positive electricity, the smallest amount that exists.

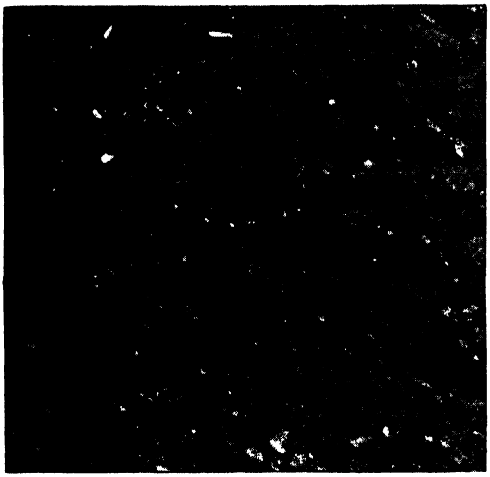
The second of these particles, the electron, carries the same amount of electricity, but of the opposite kind, so we say that the proton has a positive charge, and the electron a negative one. A proton and an electron at-

Courtesy, Canadian National Film Board

A prospector examines some radioactive ore detected by using the Geiger machine that he is carrying.

tract each other very strongly, but two protons try to get away from each other—they *repel* one another, and electrons repel one another. What is strange among these very small particles is that while they have the same amount of charge, the electron weighs only about 1/1850 as much as the proton.

The third particle, the neutron, weighs virtually the same as the proton, but it has no electric charge; that is why, of course, we call it a "neutron." A neutron seems to be a proton and an electron locked close together, canceling one another's electric charge. Scientists guess that a proton may be around a trillionth of an inch in size. Though there is no way of seeing such particles, we have been able to devise several ways of making visible their effect on gases. And we have many photographs that show the path of a single proton or electron. These, of course, are particles that do not belong to any atoms; we call them free protons and free electrons.



Courtesy, Canadian Radium and Uranium Corporation

Magnified crystals of a radium salt. Radium is usually sold in the form of a salt compound like this.

The article on Atoms, page 524, tells how protons, electrons and neutrons combine to make the different elements, from hydrogen, which has one proton and one electron, to uranium, which has 92 protons, 146 neutrons and 92 electrons. Always an atom has an equal number of protons and electrons, that is—an equal number of positive and negative electric charges, which add up to no charge.

The protons and neutrons are packed tightly together in a lump in the center of the atom. We call the lump the nucleus. The electrons circle round the nucleus at high speed. The electrons seem to be arranged in layers or shells, and the shells follow certain patterns. The uranium atom has 2 electrons in the shell nearest to the nucleus, 8 in the next shell, 18 in the next, then 32, 18, 12 and 2.

An atom with 238 protons and electrons is heavy, too heavy. The forces that hold nuclei together are not strong enough, and so the uranium atoms sooner or later begin to fall apart. As a nucleus falls apart it sends out the rays we have been speaking of—the alpha, beta and gamma rays. That is what radioactive means.

The alpha rays are chunks from the atom, two protons and two neutrons locked together. It is more exact to call them alpha particles. They carry a double electric charge.

The beta rays are also particles. They are electrons. Yes, they are electrons that come shooting out of the nucleus, though there are no electrons in a nucleus. What happens is that a neutron violently splits into an electron that dashes out and a proton that stays behind.

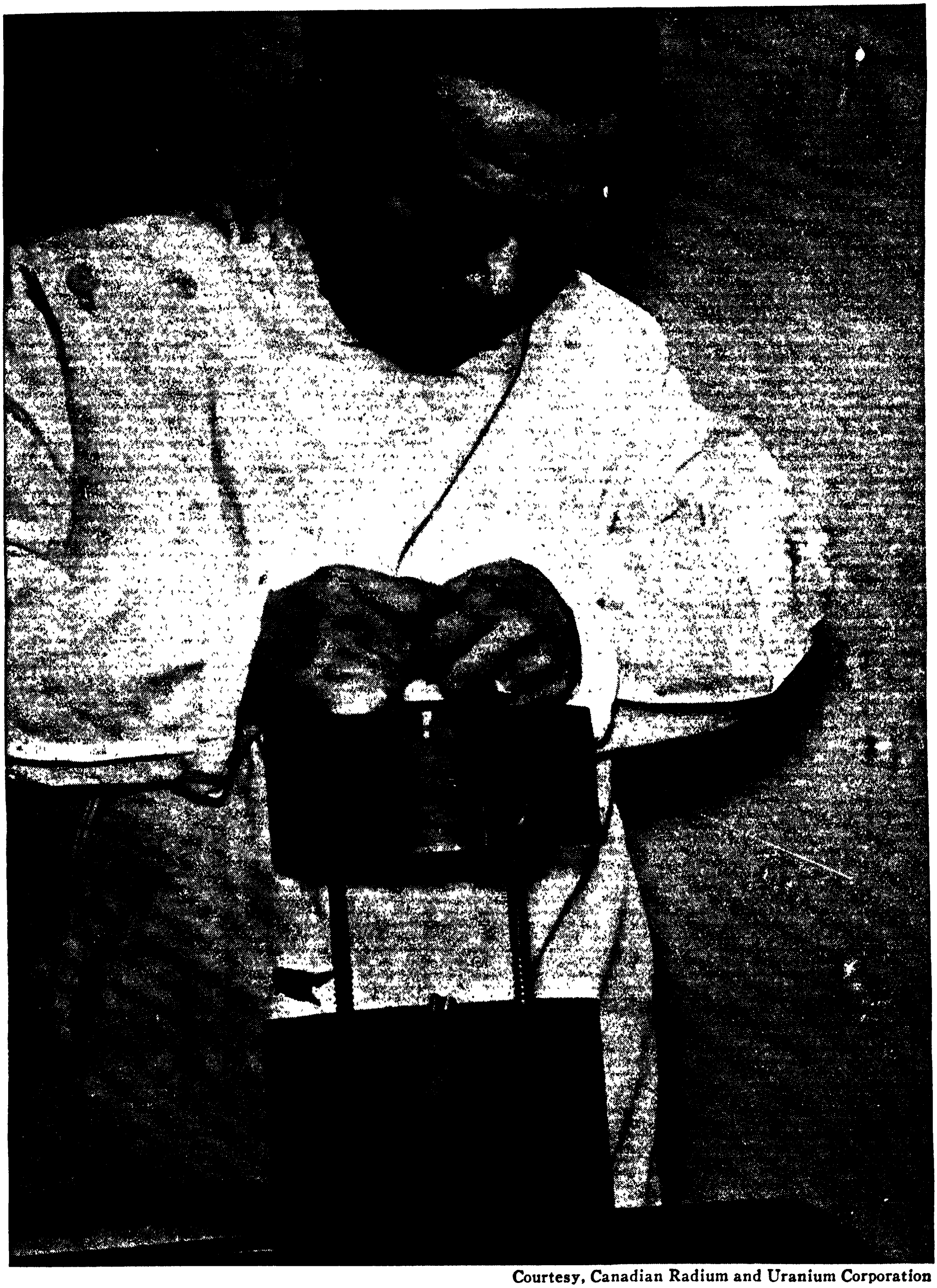
The gamma rays are not particles, but real rays.

In the past chemists had always found that whenever chemical elements "reacted" with each other they could speed up this reaction by heating, and slow it down by cooling; or, if they were dealing with gases, by compressing the gas or thinning it out. But the remarkable thing about these radioactive substances is that nothing we can do changes the way in which they send out their alpha, beta and gamma rays. We know now why this is so, of course. In chemistry we are really dealing with the outside layers, or shells of the atoms—but radioactivity comes from the nucleus, where we can not get at it, for the nucleus is too well protected by all these outer layers. We shall come back to this later on in the chapter.

WHAT AN "EMANATION" IS, AND HOW IT CAN PRODUCE SOME STRANGE EFFECTS

As we learn more about radioactivity we have to use many new words and terms to describe what happens. One of these is "emanation," which we use to describe the gas that is produced by some radioactive elements. Usually this gas is itself radioactive. With the radioactive element actinium, for example, we can make this experiment: we wrap some substance that has actinium in it in a thin sheet of paper and take it to a

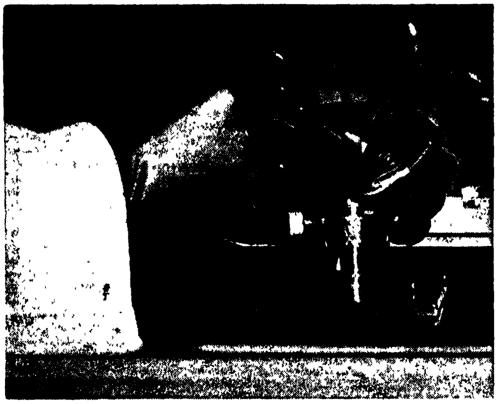
PREPARING TO SHIP SOME RADIUM



Courtesy, Canadian Radium and Uranium Corporation

Because of the strong radiations which it gives off, radium has to be carried in containers of very heavy lead.

dark room. We then lay it on a screen on which we have smeared a little phosphorescent material such as zinc sulfide. After a while, this screen will begin to glow all around where the actinium lies. But if we blow at it, the glow goes away for a few minutes and then comes back. This proves that it is not the actinium itself, but a gas arising from the actinium which makes the screen glow.


Courtesy, Canadian Radium and Uranium Corporation
Filling little, needle-like containers with radium salt. Note the protective gloves on the man's hands.

Often, too, we find that almost any object that gets close to such an emanation behaves as if it were radioactive itself. What happens is that when the emanation gas touches a metal wire, for example, it leaves a very, very thin film as a coating on the wire, and this thin film stays radioactive for a while. As the film is so extremely thin we can not see it, and so the wire seems to have become radioactive.

While the only rays known to be sent out by radioactive materials are alpha, beta and gamma rays, there is still a good deal of difference in the way they do it. We might say that there are only three kinds of radioactive guns, each shooting only one type of bullet, but some shoot much faster than others, and there is a difference in the amount of explosive used by each.

We can measure the speeds of the alpha and beta particles. They are electrically charged, so when we make them pass between two powerful magnets, or between two plates charged with high voltage, they no longer move straight, but begin to turn and travel in a curve. By this means we have found out that the alpha rays travel at speeds of 10,000 miles per second or more. Among these very tiny particles this is not really a very high speed and they usually do not get very far. A thin sheet of paper, or even an inch or so of air will stop them. The faster they go, the farther they can travel before they get stopped—the slowest alpha particles get stopped after one inch of air, but the fastest, with speeds of about 15,000 miles per second, can travel nearly 4½ inches. The beta rays are very much lighter, and they travel much faster than alpha particles. Some of them have speeds up to 180,000 miles per second; that is almost the speed of light. They can also go much farther. They are much more penetrating, as we call it; they can go through sheets of paper easily, and even through a sheet of aluminum a tenth of an inch thick.

Since the gamma rays are not particles, but behave like invisible rays of light, we can not make them curve around between magnets. But they are very much more penetrating than the alpha and beta particles. They can get clear through a piece of iron eight inches thick, or even through one inch of lead.

All of these rays represent energy being spent—like a bullet traveling through air. When they are stopped this energy is turned into heat and we can measure this heat. We find it easier, though, not to express the amount of heat they would produce, but, especially with the beta particles, to say that they behave in exactly the same way as an electron which moves between two electrically charged plates that have a very great difference in voltage, such as three million volts. And so the physicist says that such a beta particle has an energy of three million electron-volts, meaning that it has a quantity of energy equal to that gained by one electron when it travels from one electrically charged plate to another which is charged three million volts higher. He writes that 3 Mev, and this is another of the new terms we have begun to use in radioactivity.

AN EXPLANATION OF THE TERM "HALF-LIFE" AS IT REFERS TO RADIOACTIVE ELEMENTS

Still another term is "half-life." To explain what that means we have to look at radioactive atoms in the same way as an insurance company looks at people. When a person who is 30 years old takes out life insurance he pays a certain amount of money each year to the company, and the company, in return, promises to pay, say, $10,000 to his children when he dies. Now if he should die the day after he takes out his insurance

A LEAD-LINED SAFE FOR RADIUM

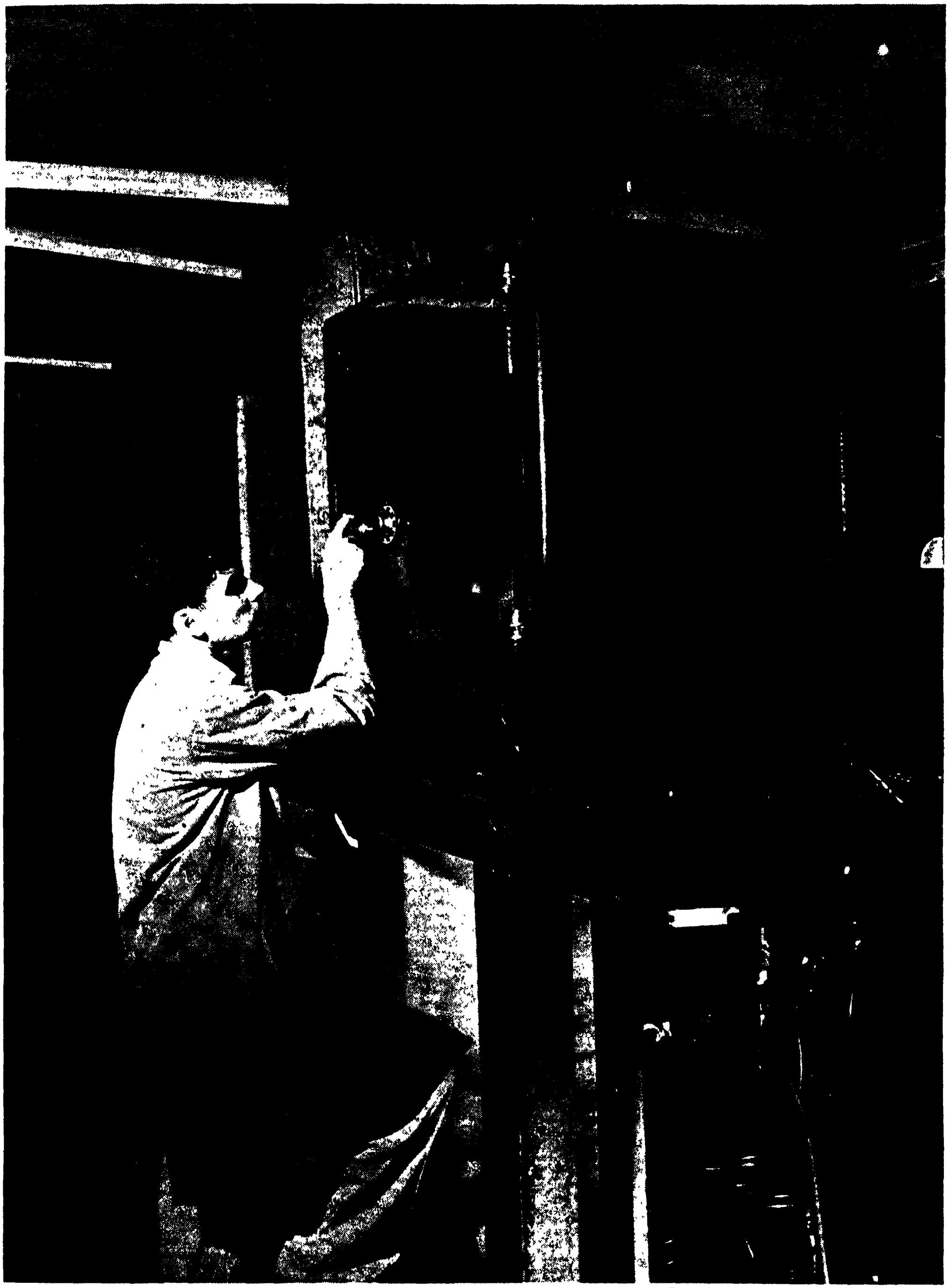


Photo by Acme Newspictures, Inc.

The radium vault at Memorial Hospital, New York. Doctors use the magical rays of radium to help cure disease. Because of the burning rays it gives off, and also its great value, utmost care must be taken in storing the metal.

the company will lose a great deal of money, but if he lives until he is over 90 years old, the company will make a lot of money. No one ever knows what is going to happen to any one person, but from their records and tables the insurance companies know that once people have reached the age of 30, say, they will, on the average, live until they are about 70. So the companies calculate their premiums in this way; then they are sure that on the average the company will make a little money. The same is true for radioactive atoms: if we had just one atom we could not tell what would happen to it. But even in a pinpoint there are more than a million times a billion atoms; and physicists now say (from their experiments) that among a particular kind of atoms, it will take, say, one day before one per cent of them has sent out an alpha particle. Now this would *not* mean that after one hundred days there would be nothing left. It does not work that way. Let us take another case. Let us start out with 1,000 atoms, and suppose that 100 of them, or 10 per cent, break up the first week. That leaves 900, and 10 per cent of 900 is 90, so the second week 90 atoms break up, leaving 810. Ten per cent of that is 81, so at the end of the third week there will be 729 left, and 73 would break up the fourth week, 66 the fifth week, and 59 the sixth week, leaving 531 at the end of the sixth week. So, while 10 per cent would break up the first week, it takes six weeks and four days before 50 per cent has broken up, and that length of time we call the "half-life" of that kind of atom.

HALF-LIFE MAY VARY IN DIFFERENT ATOMS FROM YEARS TO FRACTIONS OF A SECOND

For different radioactive elements the half-life varies enormously, from 22 billion years for ordinary thorium, to a one-hundred-billionth of a second for another kind of very radioactive thorium. To give you an idea of how active even so slow an element as ordinary thorium is: Suppose we had just one ounce of pure thorium, and we could make visible by a flash every alpha particle sent out by it. We should see 60,000 flashes every second, and after 22 billion years still only half of that one ounce would have been broken up.

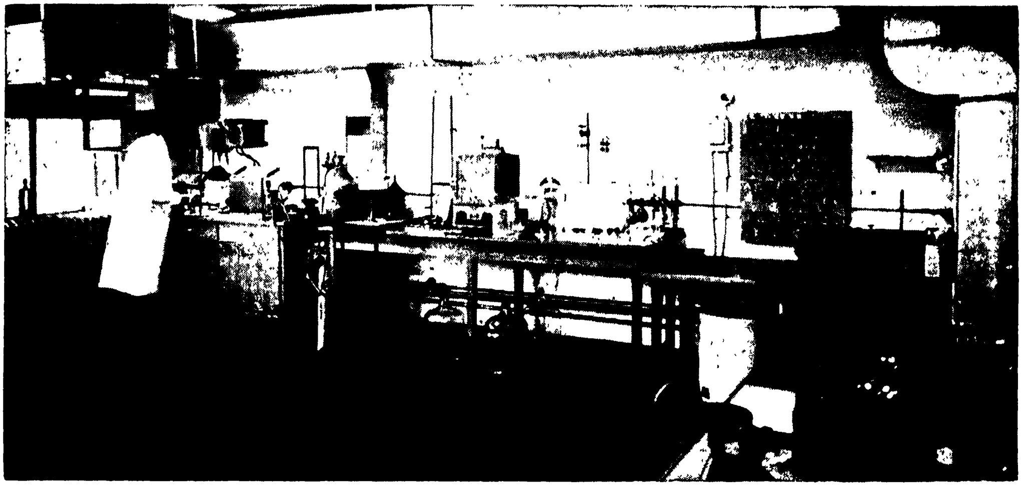
We said that each atom always has the same number of electrons moving on the outside as it has protons inside the nucleus. What happens when the nucleus shoots out an alpha particle—that is, a combination of 2 protons and 2 neutrons? Doesn't that change the electrical balance of the atom? Yes, and the atom must balance itself after the explosion. What happens when the uranium nucleus, for example, shoots off an alpha particle, is that the atom that weighed 238 before now weighs only 234. It has two protons, that is, two positive charges less in the nucleus, so it must also lose two negative charges, that is, it must lose two electrons. It does this by getting rid of two electrons from its outer shell. This will change its chemical properties and make it behave somewhat similarly to thorium. So we see that when a radioactive element shoots off an alpha particle it loses in atomic weight and changes its chemical properties as well, in other words it becomes a NEW chemical element. This is the dream of the Middle Ages. It was known as alchemy, the changing of one chemical element into another. The technical name for it is "transmutation" of elements. What they really wanted to do in the Middle Ages was to make gold out of cheaper metals. We still can not make gold out of cheaper metals. That is, we might possibly change a few atoms of one element into gold, but to make a pound of gold from cheaper elements by transmutation would take us thousands if not millions of years.

What happens to the electrical balance of the atom when it shoots out a beta particle? In this case a neutron in the nucleus splits into an electron—the beta particle that darts away—and a proton that stays behind. Now the atom has one more positive charge than it had before, so in its outer shell it has to pick up one more electron. That is not difficult. There are always plenty of slow electrons loafing around in space; that is, they are not traveling faster than a few thousand miles per second. After an electron has been captured, the atom has again changed its chemical behavior, though this time not its atomic weight.

ONE OF THE RADIOACTIVE SERIES STARTS WITH ORDINARY URANIUM METAL

Usually the story does not end there; for when an atom is radioactive and shoots off an alpha particle or a beta particle it does not stop, but keeps on sending out more alpha and beta particles, and changes progressively into a number of other elements. Finally it settles down to what we call a stable element. Such a whole chain of radioactive changes we call a series, and at present we know three of them. One begins with uranium, one with actinium and one with thorium. The first one is the most famous because radium belongs to it, so let us look at it a little more carefully.

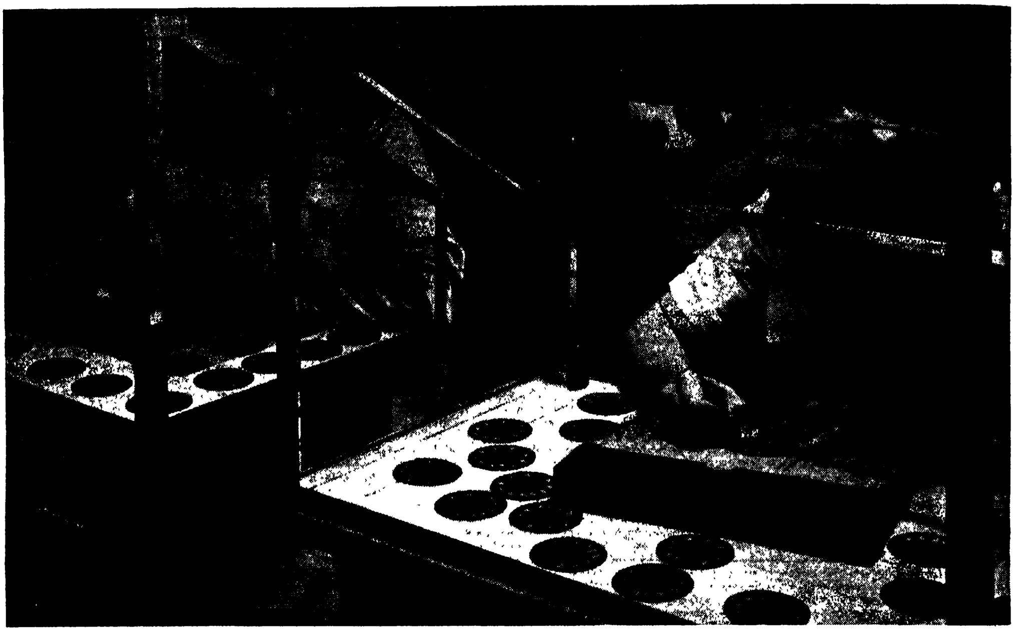
It begins with ordinary uranium, an atom of total weight 238, containing 92 protons, 146 neutrons and 92 electrons. First it shoots off an alpha particle, rather slowly, for the half-life of uranium is several billion years. It then becomes uranium-X_1 of atomic weight 234, but chemically nearly the same as thorium. This breaks up again by shooting off a beta particle, living a half-life of three weeks, and changing into uranium-X_2. Now uranium-X_2 does the same thing again, but much faster, living a half-life of only a little more than one minute and changing into uranium II. But now, after first having lost one alpha particle with two positive charges, and two beta particles with one negative charge each, the atom has not changed electrically at all. However, it has changed in weight down to 234, and what we have is a new form of uranium, known as an "isotope" of that metal. An isotope is almost the same as the original element except that it has a different atomic weight and a different density. This again breaks down very slowly, with a half-life of 300,000 years, giving off alpha particles and becoming ionium, of weight 230, and chemically again similar to uranium-X_1 and thorium. With a half-life of 83,000 years, ionium sends out another alpha particle and changes into radium, the most famous radioactive element of all. It has a weight of 226. Chemically it is similar to magnesium. Radium continues the activity and sends out an alpha particle. Any given amount of radium is half used up in 1,600 years. It changes into radon, or radium emanation, a very heavy gas, of atomic weight 222, and chemically similar to neon. But radon is very active; its half-life is only four days, after which, by sending out another alpha particle, it changes into radium A which again shoots off an alpha particle and is half gone in three minutes, becoming radium B. By this time we have lost six alpha particles and the atomic weight is down to 214. The chemical behavior is somewhat the same as that of lead. It is an isotope of lead. But even this atom is still radioactive, very much so; by shooting off beta particles, and after a half-life of a little under half an hour it changes into radium C, which repeats, and with a half-life of twenty minutes becomes radium C^1. This is the champion performer of them all, for after a brief life of only one-millionth of a second it sends out alpha particles and changes into radium D, now with an atomic weight 210, and again an isotope of lead.



Courtesy, Canadian Radium and Uranium Corporation

Working with radioactive substances in a laboratory. Rays from these materials can burn the cells of a man's flesh. Therefore, precautions such as special working clothes and frequent medical examination must be taken.

Here we slow down a little, for radium D has a half-life of 22 years. It gets rid of another beta particle, becoming radium E which does the same trick, only faster, with a half-life of only five days. It becomes polonium. For the last time we get rid of one more alpha particle, and after a half-life of 140 days we wind up with an atom that weighs only 206 (we have lost 8 alpha particles, or 16 protons and 16 neutrons out of



Courtesy, Canadian Radium and Uranium Corporation

Printing with luminous paint. By mixing a tiny amount of radium with zinc sulfide it is possible to produce a luminous compound which glows in the dark. These paints are used on watch and clock dials, among other things.

our original uranium atom). The new atom has the chemical properties of lead. Now it has come to stay, for this isotope of lead no longer changes; it is really stable.

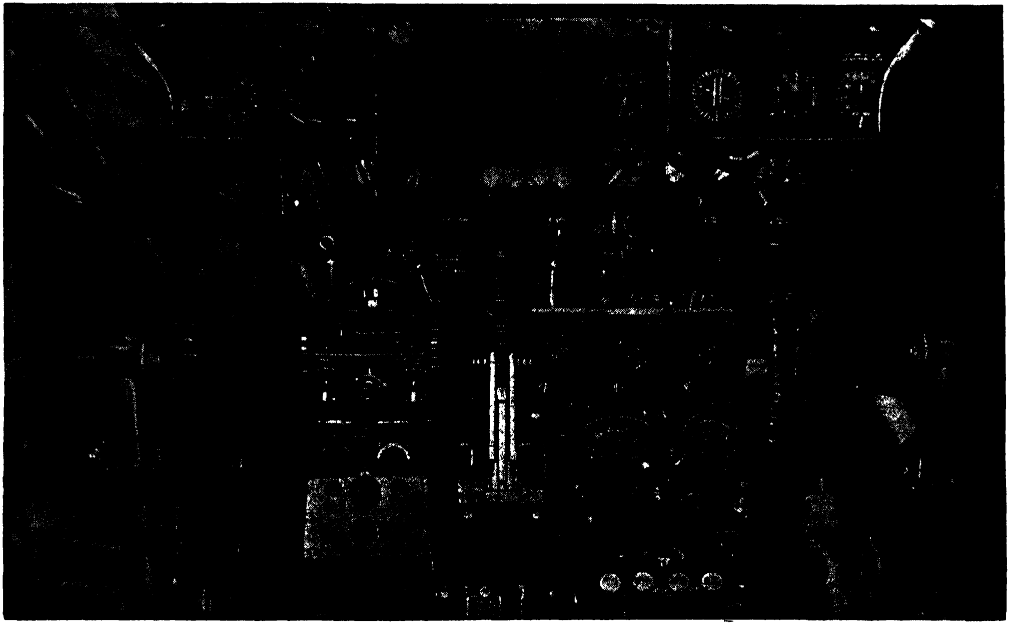
Just how physicists have gone about proving every one of these steps we can not explain. It has been a long and difficult task. The other two series, one beginning with actinium, the other with thorium, also end up with lead, and again they stop there—radioactively speaking, this lead is dead. But—and this is the interesting and important part—while all these end-products are isotopes of lead and behave exactly the same way chemically, they do not have the same weight. Uranium-radium lead weighs 206; actinium lead weighs 207, and thorium lead weighs 208. Now if we take an ore such as thorianite, which comes from the island of Ceylon and which contains a great deal of uranium, we always find a small amount of lead in it —some of it must be thorium lead, and some uranium lead, and if we examine it very carefully, we can tell these two kinds of lead apart. Next, if we know the half-life of all the intermediate products we can calculate how long it would have taken for the uranium in this ore to have produced the uranium lead, and how long for the thorium to have made the thorium lead, and if these two answers agree, then we have a pretty good idea how long ago that particular piece of ore was formed.

We do not yet know exactly how the earth was born, but we do know that in the beginning the earth was so hot that its materials existed in the form of gases; then gradually they cooled off and became liquid, much like lava, and still later this lava froze into rocks. So long as the earth was still a gas or a liquid everything could move around and mix, but once it became a solid piece of rock the particles could not get away from each other any more—the uranium lead had to stay with the uranium from which it was made. The answer that we were getting above then tells us how old the rocks are in the crust of the earth. The best answer we have up to now is about 1,850,000,000 years. We can make a very good guess that the time the earth was a gas or a liquid was very much shorter than this, and we may therefore say that the earth was born about two billion years ago.

Since radium is the best know of all radioactive elements let us talk a little more about it—where it is found, what it looks like and so on. Radium is always extracted from uranium ores, and the first radium ever obtained, by the Curies in Paris, came from uranium ore mined at Joachimsthal in Bohemia. This is a very rich ore called pitchblende, but there is not a great deal of it. In the United States there are some ores in southwestern Colorado, and Utah, called carnotite, which is rather poor in uranium and radium. The richest of them all lie in the Belgian Congo. These African ores are called soddite after Frederick Soddy, an English scientist who worked with Rutherford. Large deposits of uranium-radium ore have been found near Great Bear Lake in Canada. The Eldorado mine there lies only twenty-six miles from the Arctic Circle. How long and difficult a job it is to get the radium pure, you can guess from the fact that 100 tons of uranium generally contain only one ounce of radium. At first one gram of radium cost $100,000 (nearly $3,000,000 per ounce); but after the discovery of the ores in the Congo and in Canada the price dropped to $20,000 per gram. Just before the war the whole world produced about four ounces of it per year, most of it going to the United States where medical use alone was more than one ounce per year.

Close-up of an artificial horizon, an instrument used in flying. It is coated with luminous paint.

Pure radium is a shiny white metal that melts at 1,300 degrees F., but tarnishes quickly in the air. Chemically it is similar to magnesium and to calcium. If we could count the alpha particles sent out by an ounce of pure radium, we should see a million times a million flashes every second. And so you can see how it would be possible, by using very sensitive electrical instruments, to prove the presence of one ten-millionth of a millionth of an ounce of radium. This is very lucky indeed, for sometimes one of those tiny glass tubes with a radium preparation in it, worth thousands of dollars, gets lost in a hospital. Then a physicist is called in and he often "spots" it in an ash can, or a wastebasket, where it has been dumped with sweepings from the floor, or even in the sewer. After radium sends out its alpha particle it changes into radon, or radium emanation, the heaviest known gas. It boils at a very low temperature, and as a liquid it is



Pictures, courtesy, Sperry Gyroscope Company, Inc.

The instrument panel of a four-engine airliner. Most of these dials are treated with luminous paints for night use.

nearly as heavy as iron. Radon is extremely active in sending out its rays and particles —100,000 times as active as radium itself—even at hundreds of degrees below zero it shines with a bright pink glow.

A tiny speck of radium sends all its alpha rays into the air; but in a larger amount, even as little as a pinhead, the particles sent out by the interior get stopped by the outer layers. And so the radium heats up, and the physicists have found that a small piece of radium would heat up its own weight of water to the boiling point in about forty-five minutes. From this we have calculated that a large part of the heat inside the earth comes from radium, and because the earth is not getting any hotter, we can also estimate that there can not be more than 300 million tons of radium altogether in the earth. This sounds like a good deal, but it is really only one part in 20,000,000,000,000 when you consider all the material of which the earth is made.

HOW THE RAYS GIVEN OFF BY RADIUM ARE USED TO HELP CURE DISEASE

We have said that radium is used in medicine. The way this came about is very interesting. In 1901 Becquerel, while working with radium, accidentally burned himself; then Pierre Curie deliberately tried to do the same to himself, and in this way began what we call radium-therapy. What happens is that the rays sent out by radioactive substances can "burn" and even kill and destroy the cells and the tissues in plants and animals. So, just as with X-rays, doctors tried to find out whether radioactive materials could be used to cure cancer and certain skin diseases. But very early it was found that radioactive substances are extremely dangerous and must be handled with the utmost care. At first, if a radium preparation were given, it would often cure a cancer by killing the diseased tissue, but after that it went on radiating and burned healthy tissue and sometimes even killed the patient. Then it was found that radon—the radium emanation which is a gas—is thousands of times as effective as radium itself. A method has been developed whereby some of this gas is sealed in a very thin glass tube, and this "needle" is inserted into the sick part of the body. Four hours after the preparation is first made it reaches its greatest activity, and after four days—its half-life—it begins to die down.

Another field where radium and other similar elements found a practical use is in luminous paints. To make these a very tiny amount of radium is mixed with zinc sulfide—1 part in 10,000 or so. Zinc sulfide has a strange property. When it is hit by the rays sent out by radium, which we can not see, it begins to glow with a sort of a greenish light. For the first three weeks after the paint has been mixed this glow gets brighter and brighter, then it drops off to about one-fifth of what it was at first, and stays that way for many years. You have undoubtedly seen matches and alarm clocks in which the numbers on the dial and the hands had been painted with some greenish looking stuff. That is—it looks greenish in daylight. But take the watch into a dark closet, or look at it by night. You will see the figures on the dial glow. A great advantage of this light is that while you can easily read the time on your watch and clock, when you are near, the glow is really so feeble that a few yards away it is entirely invisible. This made it useful during the war. Instruments on ships and sights on field guns, and rifles were treated with luminous paints. It was used, too, in painting signs on air-raid shelters and spots that had to be made visible during a blackout.

Luminous paints find a great deal of use on the instrument panel of airplanes. We may see it a good deal on the dashboard of our cars and you have probably seen it used on the little tips of the pull-chain for an electric-light fixture, on doorknobs and other things which we have to find in the dark. In the next few years we may see a tremendous increase in the use of these paints, especially if the price of radium comes down still further, and if we can make sure that by using it so much we do not run the risk of getting radium burns.

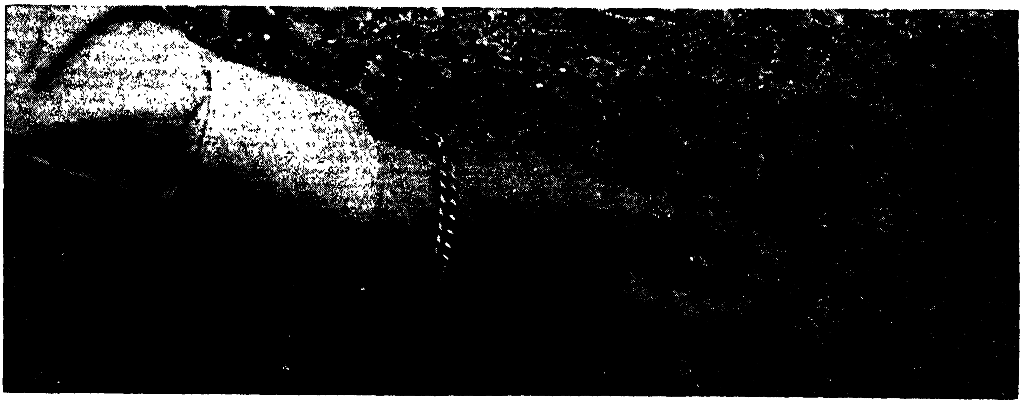
UNLIKE OTHER PROCESSES, RADIOACTIVITY CAN NOT BE SPEEDED UP BY USING HEAT

Scientists have made a great many experiments with all kinds of atoms and have made atoms do all kinds of things. But these things could always be influenced by heat or cold, by electricity or magnetism. Take coal and oxygen—leave them together at room temperature and nothing happens. But heat the coal to the right temperature and it begins to burn, that is to say, it unites with oxygen to form carbon dioxide. But if we heat the carbon dioxide still more, it begins to fall apart again. Not so with radioactivity: the rate at which radium is shooting off alpha particles can not be changed by any means we know, and in this way radioactivity is unique. We now understand why: the chemical behavior of atoms depends upon the outermost layer of electrons and naturally, by heating or cooling, or putting electrical forces on it, we can "get at" that outer layer fairly easily. But radioactivity happens to, and in, the nucleus which is way inside the atom, and is well protected by this barrier of several layers of electrons. It is the same with a house: if there is a strong wind howling outside, it will rattle shutters, and shake windowpanes, tear some shingles off the roof, or perhaps even blow the chimney down, but in a well-built house you will not be bothered by the storm when you lie snugly tucked into bed. So the problem was: if we want to do something to radioactivity we have to get through to the nucleus itself.

How can we do it? Rutherford saw the solution. A radioactive atom shoots off alpha particles, so why not try to shoot alpha particles at the nucleus? Now that is easier said than done, for not only is the nucleus very, very tiny, but no one can see it, so we can not take aim. It is as if a man were to go out on a pitch-black night, into a forest, hunting for a pheasant. If he blindfolded himself, and then fired one shot from a .22 rifle, he would not have much chance of hitting the pheasant. But if he fired a machine gun, turning it in all directions and for several hours, he might score a hit. That is just what Rutherford did: he built a machine that produced a constant stream of alpha particles, and then bombarded his atom with those. And in this way he found that a nitrogen nucleus, weighing 14, actually could catch an alpha particle with weight 4 and then would temporarily become an atom of fluorine—not an ordinary one, of weight 19, but an isotope, of weight 18. Then something else happened, for this kind of fluorine apparently is not stable—it broke up into heavy oxygen (17) and hydrogen (1). And so, for the first time, man had put a helium and a nitrogen atom together and made oxygen and hydrogen out of them. He had changed one chemical element into another. He had succeeded in transmuting one element into another. This was in 1919, and immediately a great many scientists began bombarding all kinds of atoms in this way, to see what happened. Let us look at some more of those experiments in detail, because they led to a very important discovery.

When the very light metal beryllium—like magnesium, but still lighter—was bombarded with alpha particles the same thing happened. Beryllium with a weight of 9 took up an alpha particle of weight 4, but immediately the new atom, with a weight of 13, split, becoming ordinary carbon of weight 12, and shooting off a particle of weight 1. But—now it was found that this particle had no charge at all, and Chadwick in England, who discovered this, called it the NEUTRON, and for this discovery he was given the Nobel Prize in physics. Now that we know about the neutron we understand much better how an atom is put together, and the whole story we told you before would have been unknown if it had not been for the discovery of the neutron.

At first it was difficult for physicists to get the alpha particle going fast enough for these bombardments. They built several machines, guns, from which to shoot these particles. One of the most successful of them is the cyclotron, invented by Ernest Lawrence in California in 1931. About the same time



Acme

The terrific heat given off by the explosion of an atomic bomb turned grains of sand into green particles which looked like glass. Two months after the blast the particles still contained small amounts of radioactivity.

that the neutron was discovered, Anderson, at the California Institute of Technology, found another new particle, one that weighs as little as an electron, but has a positive charge. He called it a positron.

A few years later brought still another great discovery, Frédéric Joliot and his wife, Irene Curie, the daughter of the famous Pierre and Marie Curie, found in 1934 that when they bombarded ordinary aluminum with alpha particles, a stream of new rays, or particles, was sent out which they found to be positrons, but—and this was the great, new thing—after they shut off the stream of bombarding alpha particles the aluminum kept on sending out its positrons for some considerable time. In other words, they had made a new radioactive substance. Since then, experiments have been made with all kinds of atoms and we know now that nearly every chemical element can be made radioactive artificially. In most cases they break up rather quickly, their half-life being only a few minutes or hours, but sometimes they last for days and even years.

RADIOACTIVE SUBSTANCES ARE USED TO FIND OUT WHAT GOES ON IN THE HUMAN BODY

To the physicists this has opened up a golden opportunity of exploring the nucleus of the atom, and the last few years have seen a great increase in our knowledge of the secrets in Nature's storehouse. But not only the physicist was interested. The doctor, too, saw immediately that here was something very valuable for him in the treatment of disease and as an aid in finding out what goes on in the human body.

As an example, let us look at radio-phosphorus, one of the most used of these artificial radioactive materials. It is made by shooting a neutron into the nucleus of ordinary phosphorus and has a half-life of about two weeks, so it is very active for a few days. It is given to an animal or a person, and then after a few hours, after a day, and after a few days the doctors make observations with electrical instruments to see how much of it has got into the bone marrow, and into other parts of the body. They can tell by the rate at which it is taken up something about the health of the bones and organs.

Because it is radioactive, this kind of phosphorus not only shows its presence in very small quantities, but it does so from a distance. If we fed a man ordinary salt which contains the element sodium and then wanted to know how long it would take before that sodium got into his finger tips, there would be no way of finding out. But now we can have him drink a glass of water with salt in it that contains a tiny amount of radioactive sodium. We find that after two minutes the radioactive sodium has arrived in his finger tips and is literally "broadcasting" its presence there, by sending out rays and shooting particles into space. In this way humans can serve as guinea pigs without the slightest danger to themselves, and we are finding out a lot of very interesting things about our bodies; in this case how fast our stomach can digest the sodium, put it in the blood stream, and the blood stream carry it to our finger tips.

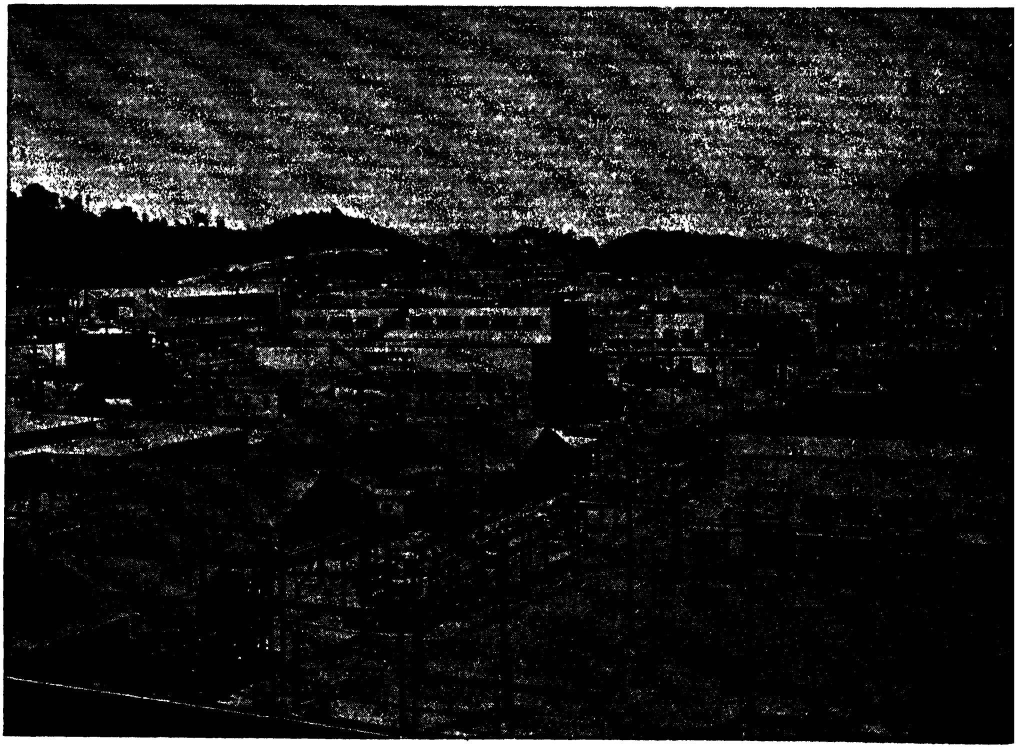
These temporary radioactive elements can serve as a label or a tag on the ordinary elements, so we talk of "tagging" or "tracer" chemistry when we use them. Radio-phosphorus is one of the tags we use most, and through it we have found that our front teeth use nearly ten times as much phosphorus as any other bones in our bodies. Also, when we use such radio-phosphorus as treatment against a tumor, its radioactivity helps to kill the tumor, but because it has such a short half-life, it does not cause any harm to the rest of the body afterward. We could not give radium salts to a person because radium and all other normally radioactive elements are very heavy. They never leave the body, and do a great deal of harm afterward by just being around. If we can use the lighter elements temporarily made radioactive then they will leave the body afterward and do no harm at all.

TRACER CHEMISTRY IS USED ALSO TO STUDY THE BLOOD, AND THE WAY PLANTS LIVE

Still other examples of this tracer chemistry are giving radioactive sulphur to rats and then observing how long it takes before it appears in their hairs, and giving radioactive iron to healthy dogs and to sick dogs suffering from anemia. In that way we found that the blood cells of the anemic dogs took up twenty times as much iron as those of the healthy dogs. By giving radioactive iodine to humans we find that most of it goes to the thyroid gland.

In the study of plants, too, these tracer materials are very useful. We have known for a long time that in the green leaves of plants, sugars and starches are made out of water vapor and carbon dioxide from the air. The botanist calls this "photosynthesis," which means the putting together of complex substances out of simpler materials under the influence of (sun)light. We know that it happens, but how it is done we do not yet know. By letting plants breathe radioactive carbon dioxide we now hope to be able to trace all the steps in between. For another thing, we know that alfalfa can take the nitrogen gas out of the air and "fix" it in its roots, where later it acts as a good fertilizer in the ground; by letting the plant breathe radioactive nitrogen we can follow the whole process in detail.

The most recent and the greatest discovery that has come out of radioactivity is the atomic bomb. The whole story of that—or rather, as much of it as we are now allowed to tell—you will find elsewhere, but the early work done on it belongs in our present tale of radioactivity. We have mentioned above that when we bombard atoms with alpha particles or with neutrons we can change them into different kinds of atoms. Rutherford originally shot an alpha particle of weight 4 at a nitrogen atom, weight 14, and got oxygen, weight 17, and a proton, weight 1. Chadwick shot an alpha particle (4) at beryllium (9) and got carbon (12) and a neutron (1). That is what usually happens; first the two add up and then separate into two very unequal parts, the smaller one being usually of weight 1. But sometimes i splits evenly, as when we shoot a proton (1) at a lithium atom (7), for then we get two helium atoms (4). Or when we shoot a proton (1) at a boron atom (11) we get three helium atoms (4 each). Now all of these atoms are fairly light atoms; but when we try the same trick on the heaviest atom known, uranium, that is, if we shoot a neutron (1) at a uranium atom of the weigh 235, this splits nearly in two, producing one atom that weighs about 127 and one tha weighs 104. There is no hard and fast rule about this, and the pieces may differ a good deal at different times, though one is always a little heavier than the other. But that is not all; 127 and 104 add up to only 231, the remaining 4 come out in the form of single neutrons—spare parts, we might call them But those spare parts are very important Suppose we hit 1 uranium atom with 1 neutron. It falls apart and produces 4 more neutrons, these might hit 4 other uranium atoms and each of those produces 4 neutrons, or 16



Signal Corps photograph

Much of the early work done in manufacturing atomic bombs took place in this plant at Oak Ridge, Tennessee.

in all, these in turn hit more uranium atoms, each of which produces still 4 more neutrons and so on. Of course, we do not always get such a perfect score; but you can see that we can well afford to have some misses. What it does mean is that once the splitting process has begun it carries on by itself, because it produces its own neutrons, its own bullets, and goes faster and faster all the time. That is what we call a chain reaction.

Now when the uranium atom splits, it not only produces two new atoms, and some neutrons, but also a terrific amount of power.

Out of one pound of uranium could come more than 10,000,000 kilowatt-hours, enough to bring to boil 100 tons of cold water. You can easily see then why people say that one pound of uranium in a bomb is as bad as 200 tons of TNT, one of our most powerful explosives. No wonder people call the nucleus of such a heavy atom a power-house; so much energy is stored up in it that we even compare it to a volcano, since it needs only one little "push" to blow up with earthquake violence.

Actually, in the atomic bomb and in much of the research being done on atomic energy, plutonium is used rather than the rare uranium isotope. Ordinary uranium can not be used, and it is easier to transform it into plutonium than it is to extract the isotope. In either case, of course, ordinary uranium is needed as the starting point for the process.

Some people think it is very wicked of the scientists to have invented the atomic bomb, and that scientists should have stopped before they got that far. But we scientists believe that it is our task to find out more and more things in nature, to learn as much as we can about what goes on in the universe. We search for the truth only, and we can never stop halfway.

THE MYSTERY OF THE COSMIC RAYS WHICH ARE STRONGER FAR ABOVE THE EARTH

Here our story about radioactivity ends, but we feel that we should tell you about one more thing that may have some connection with it: Cosmic Rays. More than forty years ago scientists found that there were always some kind of rays going through their laboratories. At first they thought that these came from radioactive materials, and since we know that we can stop alpha, beta and gamma rays by thick shields they first tried to put thick brick walls around their instruments, or sink them to the bottom of a deep lake, to surround them with many feet of water—but none of these things helped. Then they tried to get away from the ground and take the instruments up in a balloon. But instead of getting weaker, the rays got stronger, and finally Hess in Austria suggested that these rays must come from outside the earth. Millikan in California then made some more experiments; he lowered his instruments into lakes in the Sierra Nevada mountains—Arrowhead and Muir lakes. He found that these rays even manage to go through 100 feet of water, although they are greatly weakened in so doing.

SCIENTISTS NOW THINK THAT COSMIC RAYS ARE REALLY PARTICLES AND NOT RAYS

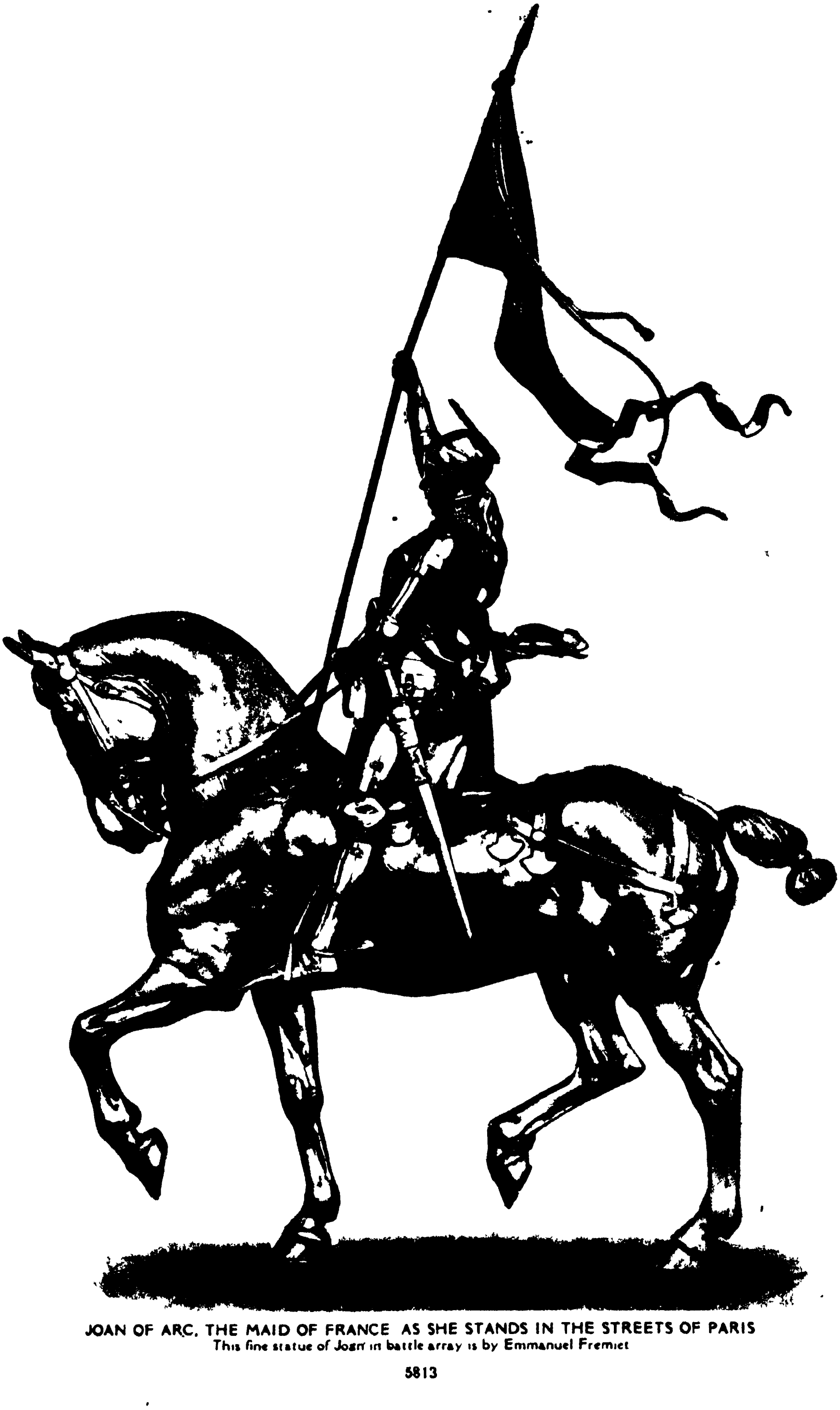
At first we thought they were real "rays" very much like X rays or gamma rays, but we now believe that they are mostly positively charged particles. These are the original cosmic rays, or primaries, as we call them. As they come down through the air they hit the atoms of the gases in our atmosphere and every time such a collision happens a gamma ray is produced; these we call secondaries, and about twelve miles above the earth there are many more secondaries than primaries. As they all move lower down, the secondaries, which carry less energy than the primaries, get stopped by hitting other atoms. And so by the time the rays get down to sea level the secondaries are nearly all gone again, and a good many primaries are gone, too. There are about 100 times as many rays twelve miles up as there are at sea level. Because cosmic-ray primaries carry electric charges they curve around a magnet—and the earth is a magnet. From this we can figure out that there should be more cosmic rays hitting the earth in the region around the Poles than near the Equator, and this is exactly what we find.

Here on the earth, where we are so near the sun, we get a great many more light rays from the sun than cosmic rays. But if we could set up a laboratory somewhere in the great empty space between the stars, then we should find that there are many more cosmic rays than light rays. Where these cosmic rays come from we do not yet know. Several guesses have been made—perhaps they come from "new" stars, which are stars that flash up suddenly due to a great atomic explosion within themselves, increasing their light 10,000 to 10,000,000 times in one night. We have not been able to prove any of these theories yet—they are still guesses.

By WILLEM J. LUYTEN.

THE NEXT STORY OF SCIENCE IS ON PAGE 5938.

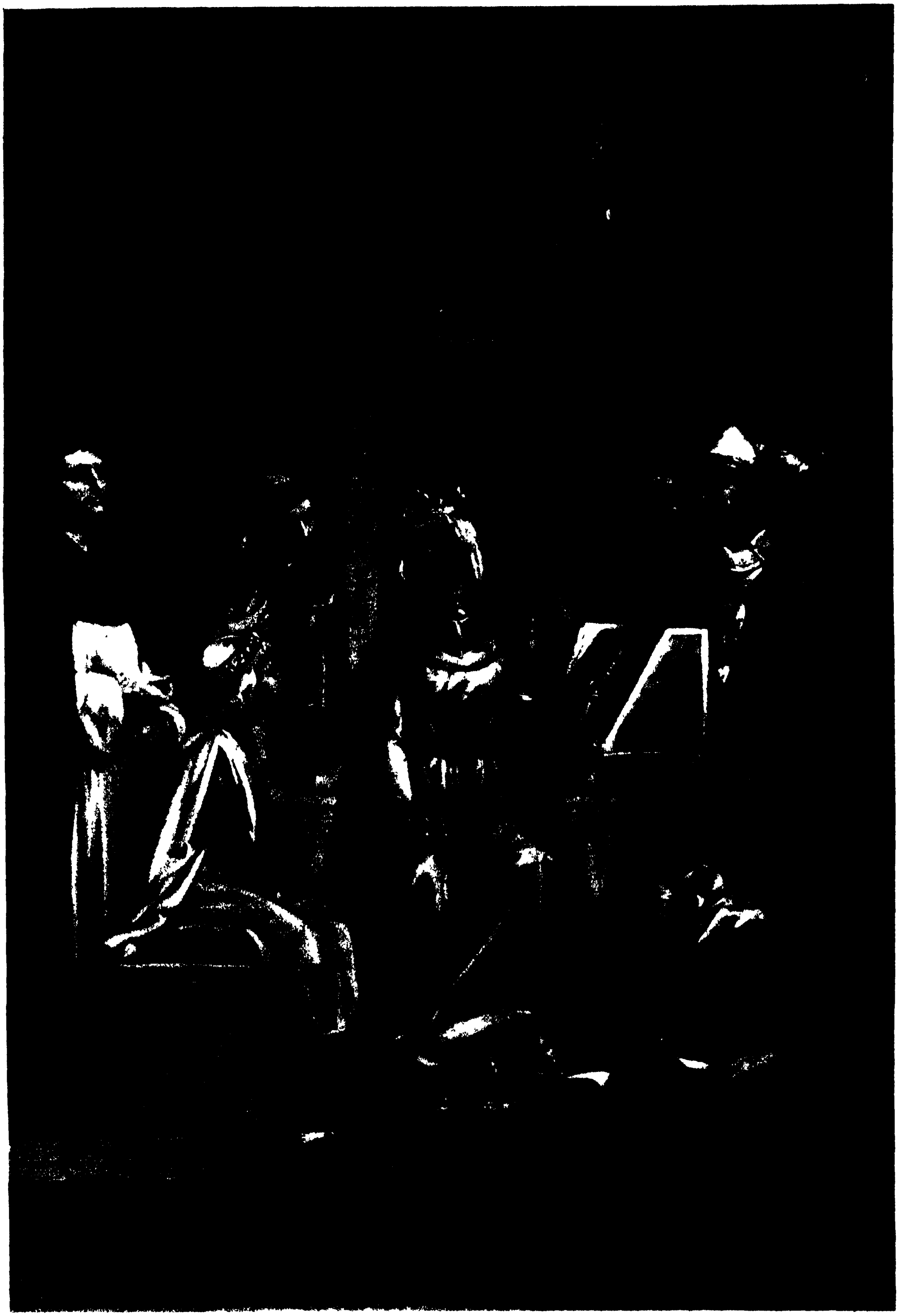
JOAN OF ARC AND ST. LOUIS



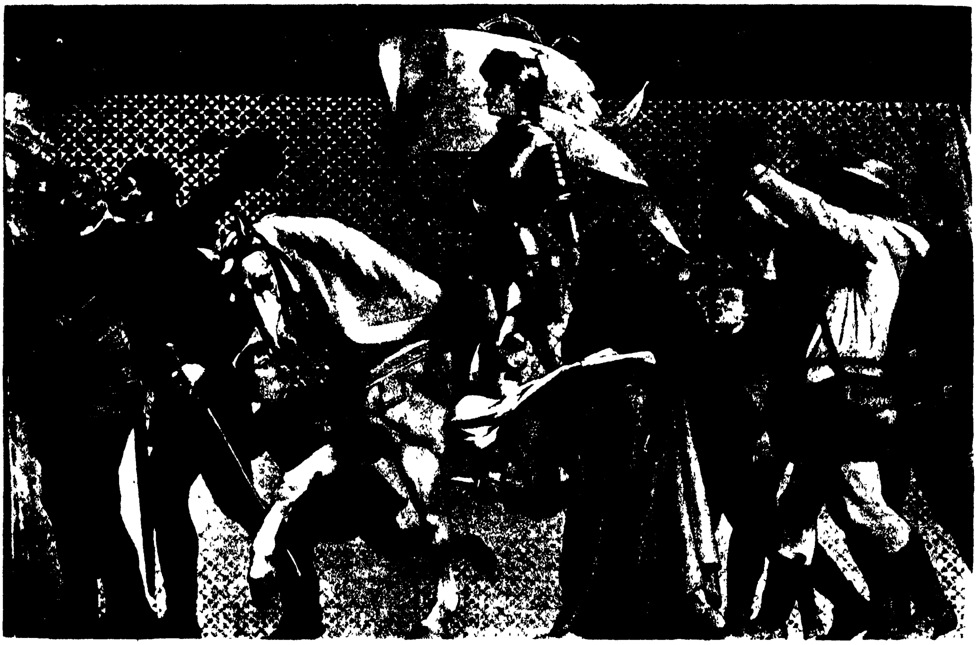
JOAN OF ARC, THE MAID OF FRANCE AS SHE STANDS IN THE STREETS OF PARIS

This fine statue of Joan in battle array is by Emmanuel Fremiet

THE GOOD KING LOUIS IX DISPENSES JUSTICE. FROM THE PAINTING BY ALEXANDRE CABANEL, IN THE PANTHEON, PARIS



LITTLE KING LOUIS AND HIS MOTHER. FROM THE PAINTING BY ALEXANDRE CABANEL, IN THE PANTHEON, PARIS



JOAN OF ARC WELCOMED BY THE POPULACE. FROM THE WALL-PAINTING BY JULES LENEPVEU, IN THE PANTHEON, PARIS

JOAN AT THE CORONATION OF THE KING AT RHEIMS. BY JULES LENEPVEU

THE LAST HOUR OF JOAN IN ROUEN MARKET PLACE. BY JULES LENEPVEU

ST. LOUIS *and* ST. JOAN

WHEN you read the history of France you read tales from the lives of her fighting sons and daughters. You read also the deeds of her daring and courageous patriots.

Though her writers and her scientists, too, made their mark on the pages of history, it is the colorful characters in war and peace who stand out most clearly in our memories.

We call to mind easily the vivid picture of Napoleon Bonaparte, that small thickset man in the cocked hat who rode across a Europe that was his battlefield; of Richelieu, the statesman in Cardinal's scarlet; of St. Louis, the Crusader, with the scarlet cross burning on his shield; of Joan of Arc, raising high her banner of the lilies; of Marie Antoinette, wearing the satins and jewels of a doomed court; of Charlemagne and Charlotte Corday; of Catherine de Medici and Talleyrand.

No one will doubt that of all the men and women France has given to the world the most astonishing was the shepherdess of Domremy, Joan of Arc; and next to her stands the Crusader King, St. Louis. These two seem almost to be legendary characters. We are inclined to think of them as ideal creatures, people out of a poet's play or a fairy tale. But we can read the story of St. Louis as written by his best friend, Joinville; and we can read the actual words spoken at the inquiry that was made into the death of Jeanne d'Arc. Monks, soldiers, herdsmen speak to us after all these years; and their words make these two—St. Louis and St. Joan—stand forth as creatures, not of marble or stained glass or painted canvas, but of flesh and blood. And it was flesh and blood that could suffer like our own. They say that Joan wept when they told her she must die by fire.

If we would understand the spirit of France, we can not do better than begin with the lives of these two heroes who have ruled the imaginations of Frenchmen for hundreds of years.

Louis IX was born in 1214, and came to the throne when he was eleven years old. How many children would be ready to envy him! In those days, they think, it was worth while to be a king; a crown was no mockery; the king's will was law to the nation. But let us see what kind of kingdom the schoolboy Louis inherited.

It was a kingdom entirely destitute of the things which to us make life worth living. Peace, safety, freedom of opinion—these things did not exist. The land was divided up among a group of barons, each as powerful as a petty monarch, each ambitious to grasp the crown for himself. As we read of plot and counterplot we think of the barons as a pack of savage dogs ready to fly at each other's throats, but first prepared to band together in attacking the lonely child who had strayed into their midst.

The boy had no friends, because his father had left a legacy of hatred behind him. Louis VIII had made war on his own people and persecuted them for their opinions. Every serf, as well as every ambitious baron, loathed the royal line.

Only a few years had passed since Arthur, the boy heir to the English throne, had been murdered, and his assassin had enjoyed the throne in safety. How was it that Louis escaped? The truth is that the story of St. Louis, like the story of so many great men, is the story of a mother. She who had soothed his babyhood was to save him now.

Queen Blanche went to the young King's most powerful enemy, a man whose family had a long-standing feud with her own, and won him over to her little boy's side. A sharp struggle followed, but in the end the right prevailed, and Louis IX was established on his throne. Until the boy was old enough his mother governed France for him.

But her greatest achievement does not lie in that; it lies in the character of Louis. When we think of the violent past we imagine that gentle-hearted women in those times could have had no active part in life. But history has left us a number of pictures of women who by their influence turned the course of history. One shows us a Saxon lady calling a boy to her knee to look at a gaily colored book. "This shall be yours," she says, "when you can read." Thus were sown the first seeds of Alfred's learning. Another picture shows us Queen Blanche training her boy to be a good king by training him to be first and foremost a good man.

Gramstorff Bros., Inc.

Louis IX, the boy king of France, giving alms to the poor.

Louis grew up into something new and amazing. He was a Christian king. It was an age when religion did not seem to keep kings from war, murder, robbery and oppression. They were all devoured with a desire to add to their possessions, by fair means or foul. Yet this new, strange character had no thought of wealth or empire. He cared for the poor, the helpless folk from whom he had nothing to fear! Surely he was mad!

But Europe soon perceived that the goodness of Louis was not weak piety. Only a man of iron will could have fought the firmly established feudal system as Louis did. One by one he drew its claws. Inch by inch he drove back the great lords and raised the poor serfs. He abolished the use of torture, trial by battle, and the persecution of a criminal's family. He reformed the currency. He recompensed those whom his father had persecuted. Justice and learning crept out of hiding into the sunshine of his reign. The people of England asked him to settle their disputes, knowing that his judgment would be the truest in Christendom.

So lovable a man could not fail to be happy in his wife and children, his subjects and friends; but when he had set France in order, he did not dream of a leisured happiness of his own. The ideals of the Crusade beckoned to him, as they beckoned to all the chivalry of his age. The kings and barons of Europe, enemies to one another, and many of them barbarous men, journeyed across the breadth of Europe to protect from desecration the grave of a carpenter's Son. Some were inspired also by dreams of adventure, some hoped to win riches, on the way. Some—and Louis was one of these—went with pure intent. This was how he came to go. In the year 1244 he fell ill, and at last was thought to be dead. A storm of weeping broke out, and somebody covered the King's face. But a woman snatched back the sheet, crying: "No! He will live to confound the enemies of God!" The dying King heard her; he rallied his failing powers and began to fight anew for life. When he had strength to speak he asked for the scarlet cross, and lay holding it to his breast. As soon as he had recovered he announced that he would set out for Jerusalem at once. His family and friends sought to dissuade him: "You were delirious when you took the cross," they said. "You are not bound by such a vow."

But Louis would not hearken. He set out with his wife and young Joinville, the comrade who afterward wrote the story of the King's life. Disaster came to the French forces, and Louis was taken prisoner. He might have escaped, but would not leave his friends. One day a party of assassins came to the dungeon to murder him, but they were overawed by his gentle fearlessness and would not do their work.

At last the desperate efforts of his wife and his friend raised the huge ransom that set him free. When in 1270 he was called to lead a second Crusade, he again left the peaceful land of France. Outside Tunis he was struck down by plague and had the agony of seeing his eldest son die of the same disease. When he knew that his own end was near he sent for his heir and pleaded with him to care for the poor and also to seek justice and peace.

After he had finished speaking he asked

to be carried from his royal bed to one of ashes. There, like a penitent, he lay praying for the people of France—that people before whom lay so many centuries of war and civil war, oppression and bloodshed. At last he was heard to murmur, "Jerusalem! Jerusalem," and with that name on his lips his crusader's soul sighed itself out.

The years passed, and again an hour of darkness came to France. At the end of a long series of wars with England she was almost completely subdued. The English regent held Paris and nearly every other important town. The rightful heir to the throne had fled to Poitiers, and by a disgraceful act of treachery his mother had bartered away his crown to England. The shame and helplessness of France was almost complete; in a few short years all this was changed by a poor, uneducated peasant maid, Jeanne d'Arc. In English her name is Joan of Arc.

THE CHILDHOOD OF JOAN OF ARC IN THE LITTLE VILLAGE OF DOMREMY

Historians may well speak of it as a miracle. Let a villager of Domremy, questioned in 1455, tell us of her childhood.

"Jeanne was born at Domremy, of Jacques d'Arc and Isabeau, his wife, laborers.... My father's house joined the house of Jacques d'Arc, so I knew her well. We often spun together....

"She employed herself at home with many duties in the house, spinning hemp or wool, following the plow or going to harvest, according to the season. When it was her father's turn, she sometimes kept the cattle and the flocks of the village for him....She was a good girl, simple and gentle. Often she was bashful when others reproached her with going too devotedly to church.

"She liked to take care of the sick; I know this of a surety, for in my childhood I fell ill, and it was she who nursed me. ...There is a tree by us called the Ladies' Tree. I have heard that the fairies came there long ago to dance. The young people of the village were accustomed to go to this tree, taking food with them. I often went there with Jeanne, who was my friend, and with other young girls. We sat there, ran about and played."

JOAN HEARS A MYSTERIOUS VOICE ONE DAY IN HER FATHER'S GARDEN

Jeanne was born on January 6, 1412. Very early the shame and sorrows of France became her own. Every week there came news of a battle or a siege or a pillaging. She brooded over these things at her work. When she was thirteen she heard a mysterious voice. "It was midday, in the summer, in my father's garden," she told the judges when, at her trial, they questioned her about the mysterious voice. "I was very much frightened. It seemed to me to come from lips I should reverence. I believe it came to me from God." From that time until the end of her brief life Jeanne was always guided by this voice from the other world.

DIVINE VOICES AND VISIONS HAVE GUIDED MYSTICS OF OTHER AGES

Socrates heard such a voice. Mystics all down the ages have had visions. In poetry we sometimes come across a passage of such beauty as makes us feel that the poet was inspired from another world:

> Though inland far we be,
> Our souls have sight of that immortal sea,
> Which brought us hither.

Because so few are able to hear this voice, those who are deaf to it may choose to believe it has not spoken. In that case they must find another explanation for the miraculous facts of Joan's life.

The voice that came to the laborer's child told her that she would save France. She received the message with a humility that never deserted her. God had chosen the lowliest of his children to accomplish His purpose for France. She never thought she had any merit of her own nor did she ever seek a reward for what she did for France.

THE MYSTERIOUS VOICE TELLS JOAN HOW SHE CAN SAVE HER BELOVED COUNTRY

Domremy lies in a little valley of Lorraine. "You must go into France!" the voice urged her, more and more forcibly. In 1428 her instructions became definite. She was to go to Robert de Baudricourt, captain of Vaucouleurs, and ask him to lead her to the Dauphin. (The Dauphin was the rightful king of France, who was being kept from his throne by the English.) The voice told Joan that the Dauphin was to give her an army. With this army she would fight the English who were besieging Orleans. She would win the fight and set Orleans free.

So Joan set off for Vaucouleurs with a kinsman—the kinsman who bore witness that "many times Robert told me to take her back to her father and to box her ears."

A knight called Jean de Metz afterward described how he saw her there wearing "a red dress, poor and worn." He asked what she wanted.

"I am come here," she answered him "to speak to Robert de Baudricourt, to the end that he may conduct me or have me conducted to the King; but Robert cares neither for me nor for my words. Nevertheless, before the middle of Lent, I must be with the King—even if I have to wear my feet to the knees! No one in the world—neither kings, nor dukes, nor the daughter of the king of Scotland, nor any other can recover the kingdom of France; there is no succor to be expected save from me; but, nevertheless, I would rather spin with my poor mother—for this is not my proper estate; it is, however, necessary that I should go and do this, because my Lord wills that I should do this."

At length she convinced the captain. He gave her man's clothing, a horse and an escort. It was an eleven days' journey to Chinon, where the Dauphin was. All the way she was in great peril from the English and their allies of Burgundy, but Joan came safely at last into the presence of the Dauphin.

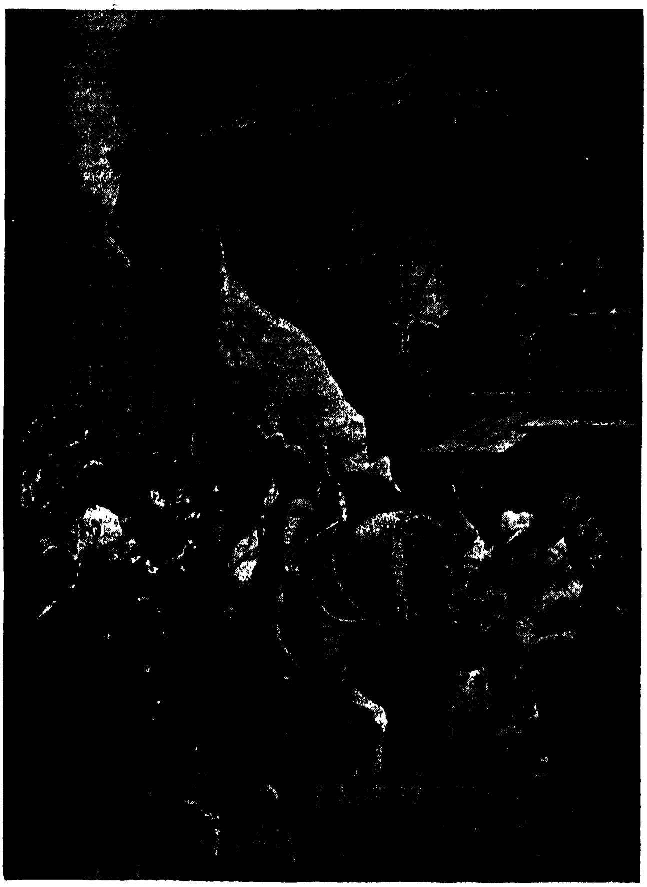
Those around the King sought to deceive her, but she knew him at once and delivered her message. He was as unwilling to believe in her as De Baudricourt had been. For three weeks she was closely examined by lawyers and theologians. One of the courtiers speaks of her as a "poor little shepherdess." Yet she convinced them.

There was something more than human about this stainless maid. She reformed the swearing, intemperate and disheartened army. She inspired it. She brought volunteers from every side. She overruled the counsel of old soldiers, and her generalship was right. The Bailiff of Chartres said: "Apart from affairs of war she was simple and innocent, but in the conduct of troops, and in actual warfare, in the ordering of battle, and in animating the soldiers, she behaved as the most skillful captain in all the world."

In three months she had raised the siege of Orleans, taken Troyes, won the Battle of Patay, and led the Dauphin to his crowning at Reims.

This her voice had promised, and this she achieved. Now she wished to go home, as one whose work is done, but the King forced her to stay. Then, instead of following her counsel, which was unflinching resistance to the English, he yielded to other advice and tried to patch up peace. He was lazy, hesitating and fearful; his father was insane, and his mother was a traitor. It was not surprising that at last, hampered by foolish orders, Joan was betrayed into the hands of the enemy at Compiègne. She was trying to regain the town, but a party of Burgundy troops reached the bridge before her. She was cut off, and after a sharp struggle was thrown to the ground and captured.

Before we pass on to her prison life let us listen to what her comrades have to say of her. Her page tells us how she sprang up from sleep one night crying, "French blood is being spilled!" how he



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Joan of Arc enters Orleans proudly at the head of her victorious army, after having driven off the English besiegers of the city.

sought her horse, while the women of the house hastened to arm her; how he passed her banner to her out of the window, and how, seizing it, she cantered to the danger point, and brought victory with her. She always carried a standard so that she need not use the sword. "I have never killed anyone," she proudly told her judges.

She was purchased by the English from Burgundian soldiers for a king's ransom, about $80,000 in modern money. The soldier who took her was given an annuity of $1,500! When she fell ill in prison a doctor was summoned. She was not to die a natural death: "she had cost too dear for that"; and she was not to die "except by justice and the fire."

Joan's trial was in every way illegal, and the lawyers who were brave enough to protest were threatened and coerced. She was imprisoned with a constant guard of five English soldiers of the lowest blackguard type. She was insulted, ill-used and heavily shackled. She was subjected to long hours of subtle questioning by learned theologians, who had promised their foreign master to procure her death.

JOAN DEFIES HER JUDGES WHEN THEY THREATEN TO PUT HER TO THE TORTURE

So wonderful were the peasant girl's replies that it was months before she was trapped into something which gave a shadowy excuse for the death sentence. According to honest notary Manchon, who took down the evidence at the trial, they falsified the records. In their own official account it is told how they took her to the torture chamber, but she said: "Truly if you were to tear me limb from limb, and separate soul from body, I could tell you nothing more!" The report concludes: "Seeing the hardness of her heart and her manner of replying, we, the Judges, fearing that the punishment of the torture would profit her little, decided that it was expedient to delay it, at least for the present."

CROWDS FILL THE MARKET PLACE OF ROUEN WHEN JOAN IS LED OUT TO DIE

At length, in 1431, a year after her capture, she was led out to die. It was at Rouen, the seat of the English regent's government. Crowds filled the market square. The judges sat on a platform. Many witnesses said: "I could not see her die, for compassion." For a month afterward Manchon could not feel at peace.

Joan had exclaimed: "I would rather be beheaded seven times than burned!" but her voice had bidden her—"Be resigned; have no care for thy martyrdom; thou shalt come in the end to the Kingdom of Paradise." She was calm now and listened patiently to the sermon which was preached before the fire was lighted. She was silent through all the abuse of herself. But when the speaker condemned the French king she cried out in his defense, for the unfortunate girl remained loyal to her false master to the end.

Several judges were moved to tears at the sight of this girl of twenty being prepared for a frightful death, but none spoke a word for her. A priest who sought to comfort her on the scaffold was hustled away by soldiers.

JOAN IS BURNED AT THE STAKE, CLUTCHING A CROSS TO HER HEART

Two sergeants hurried her to the stake. She begged for a cross, and an English soldier made one of two pieces of wood. She put it next to her heart. A monk brought the great cross from a church near by and held it toward her as the flames rose. She was heard calling on Jesus.

Joan's life did not end in defeat. She had come to a France in despair, almost empty of hope and courage, and half resigned to foreign servitude. She made France a proud nation once more; she planted in it a new patriotism. The invaders were at length driven out of the land, but the victor was not Charles, the living king; it was the peasant girl whose ashes he had thrown into the Seine.

THE PEOPLE COME TO REALIZE THAT THE MAID OF ORLEANS HAD BEEN A MARTYR

The execution took place on May 30, 1431. For several years efforts were made to impress upon the French people the fact that Joan's death had been just. But the people would not listen; already they had begun to reverence her as a martyr. Twenty years later, as a result of a petition of the D'Arc family, the Pope held a new trial and pronounced Joan innocent. The succeeding centuries saw grow up in France and other countries a cult of the Maid of Orleans. Her life and death were the inspiration for many books, poems and plays.

In the middle of the nineteenth century the Pope was petitioned to take steps to canonize Joan. In 1909 the Maid of Orleans was beatified, and on May 16, 1920, almost five hundred years after her martyrdom, she was canonized and became Saint Joan. The ceremony took place in the historic basilica at Rome, and was attended by thirty thousand people from all over the world.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 6234.

AMERICAN POETRY of the NINETEENTH CENTURY

Illustrated by Roberta Paflin

When Lilacs Last in the Dooryard Bloomed

By WALT WHITMAN
(1819-1892)

In this poem Whitman tells of his grief and the grief of the whole world over the death of President Abraham Lincoln. One of the most poignant parts of the poem is that which describes the long journey of the funeral train from Washington to Springfield, Illinois, where Lincoln was buried. The entire poem is moving and beautiful, but it is so long that we can only give the first and last parts of it here.

I

WHEN Lilacs last in the dooryard bloomed,
And the great star early drooped in
the western sky in the night,
I mourned, and yet shall mourn with
ever-returning spring.

Ever-returning spring, trinity sure to me you
bring,
Lilac Blooming perennial and drooping star
in the west,
And thought of him I love.

II

O powerful western fallen star!
O shades of night—O moody, tearful night!
O great star disappeared—O the black murk
that hides the star!
O cruel hands that hold me powerless—O
helpless soul of me!
O harsh surrounding cloud that will not free
my soul.

III

In the dooryard fronting an old farmhouse,
near the whitewashed palings,
Stands the lilac-bush tall-growing with
heart-shaped leaves of rich green,
With many a pointed blossom rising delicate,
with the perfume strong I love,
With every leaf a miracle—and from this
bush in the dooryard,
With delicate-colored blossoms and heart-
shaped leaves of rich green,
A sprig with its flower I break.

IV

In the swamp in secluded recesses,
A shy and hidden bird is warbling a song.

Solitary the thrush,
The hermit withdrawn to himself, avoiding
the settlements,
Sings by himself a song.

Song of the bleeding throat,
Death's outlet song of life—(for well, dear
brother, I know
If thou wast not gifted to song thou wouldst
surely die).

V

Over the breast of the spring, the land, amid
cities,
Amid lanes and through old woods, where
lately the violets peeped from the
ground, spotting the gray debris,
Amid the grass in the fields each side of the
lanes, passing the endless grass,
Passing the yellow-speared wheat, every
grain from its shroud in the dark-brown
fields uprisen,
Passing the apple-tree blows of white and
pink in the orchards,
Carrying a corpse to where it shall rest in the
grave,
Night and day journeys a coffin.

VI

Coffin that passes through lanes and streets,
Through day and night, with the great cloud
darkening the land,
With the pomp of the inlooped flags, with the
cities draped in black,
With the show of the States themselves as of
crape-veiled women standing,
With processions long and winding and the
flambeaus of the night,

With the countless torches lit, with the silent sea of faces and the unbared heads,
With the waiting depot, the arriving coffin, and the somber faces,
With dirges through the night, with the thousand voices rising strong and solemn,
With all the mournful voices of the dirges poured around the coffin,
The dim-lit churches and the shuddering organs—where amid these you journey,
With the tolling tolling bells' perpetual clang,
Here, coffin that slowly passes,
I give you my sprig of lilac.

. . . .

XI

O what shall I hang on the chamber walls?
And what shall the picture be that I hang on the walls,
To adorn the burial-house of him I love?

Pictures of growing spring and farms and homes,
With the Fourth-month eve at sundown, and the gray smoke lucid and bright,
With floods of the yellow gold of the gorgeous, indolent, sinking sun, burning, expanding the air,
With the fresh spring herbage under foot, and the pale green leaves of the trees prolific,
In the distance the flowing gaze, the breast of the river, with a wind-dapple here and there,
With ranging hills on the banks, with many a line against the sky, and shadows,
And the city at hand with dwellings so dense, and stacks of chimneys,
And all the scenes of life and the workshops, and the workmen homeward returning.

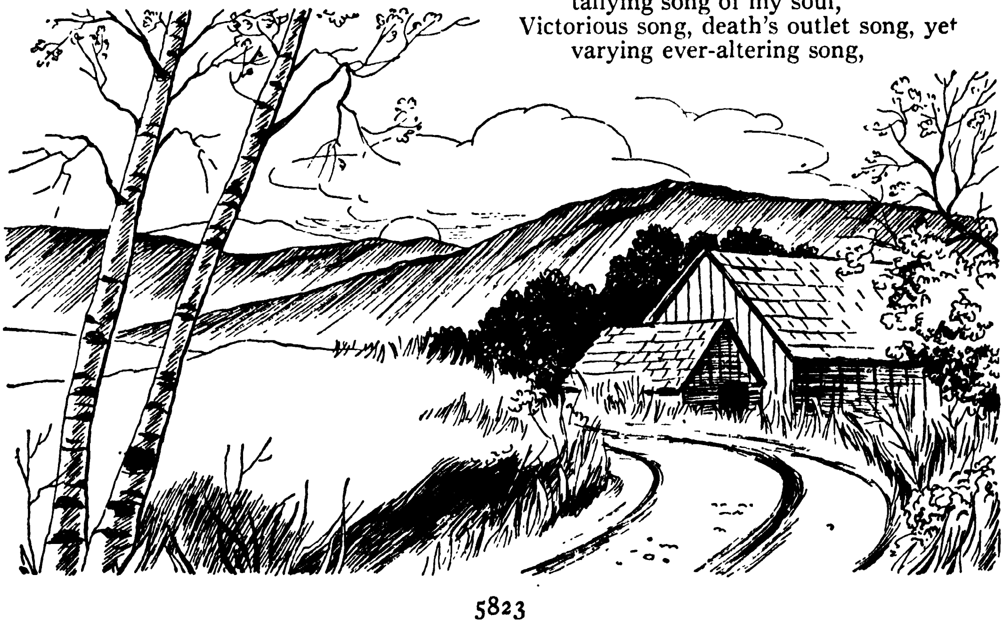
XII

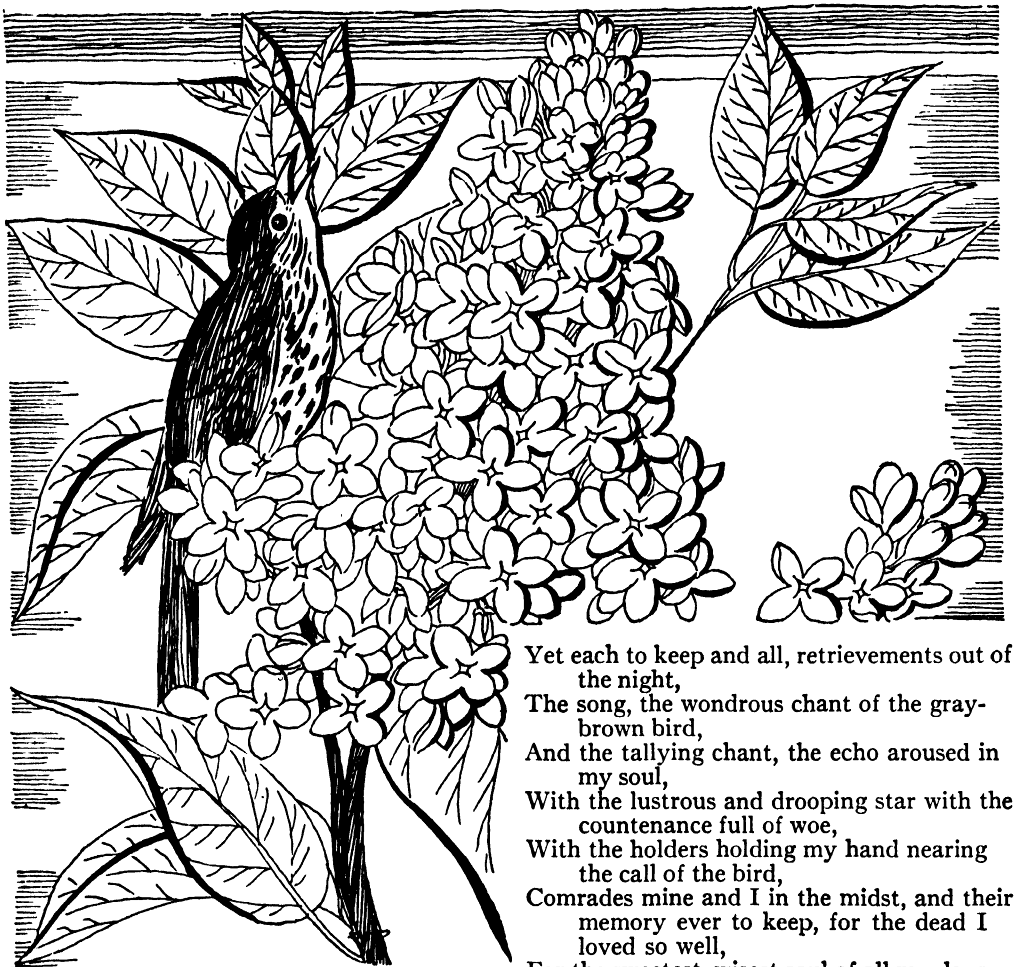
Lo, body and soul—this land,
My own Manhattan with spires, and the sparkling and hurrying tides, and the ships,
The varied and ample land, the South and the North in the light, Ohio's shores and flashing Missouri,
And ever the far-spreading prairies covered with grass and corn.
Lo, the most excellent sun so calm and haughty,
The violet and purple morn with just-felt breezes,
The gentle soft-born measureless light,
The miracle spreading bathing all, the fulfilled noon,
The coming eve delicious, the welcome night and the stars,
Over my cities shining all, enveloping man and land.

. . . .

XVI

Passing the visions, passing the night,
Passing, unloosing the hold of my comrades' hands,
Passing the song of the hermit bird, and the tallying song of my soul,
Victorious song, death's outlet song, yet varying ever-altering song,





As low and wailing, yet clear the notes, rising and falling, flooding the night,
Sadly sinking and fainting, as warning and warning, and yet again bursting with joy,
Covering the earth and filling the spread of the heaven,
As that powerful psalm in the night I heard from recesses,
Passing, I leave thee lilac with heart-shaped leaves,
I leave thee there in the dooryard, blooming, returning with spring.

I cease from my song for thee,
From my gaze on thee in the west, fronting the west, communing with thee,
O comrade lustrous with silver face in the night.
Yet each to keep and all, retrievements out of the night,
The song, the wondrous chant of the gray-brown bird,
And the tallying chant, the echo aroused in my soul,
With the lustrous and drooping star with the countenance full of woe,
With the holders holding my hand nearing the call of the bird,
Comrades mine and I in the midst, and their memory ever to keep, for the dead I loved so well,
For the sweetest, wisest soul of all my days and lands—and this for his dear sake,
Lilac and star and bird twined with the chant of my soul,
There in the fragrant pines and the cedars dusk and dim.

Memory

By Thomas Bailey Aldrich (1836-1907)

My mind lets go a thousand things,
Like dates of wars and deaths of kings,
And yet recalls the very hour—
'Twas noon by yonder village tower,
And on the last blue noon in May—
The wind came briskly up this way,
Crisping the brook beside the road;
Then, pausing here, set down its load
Of pine-scents, and shook listlessly
Two petals from that wild-rose tree.

Ballad of Trees and the Master*

By Sidney Lanier (1842-1881)

Into the woods my Master went,
Clean forspent, forspent.
Into the woods my Master came,
Forspent with love and shame.
But the olives they were not blind to Him;
The little gray leaves were kind to Him;.
The thorn-tree had a mind to Him,
When into the woods He came.

Out of the woods my Master went,
And He was well content.
Out of the woods my Master came,
Content with death and shame.
When Death and Shame would woo Him last,
From under the trees they drew Him last;
'Twas on a tree they slew Him—last
When out of the woods He came.

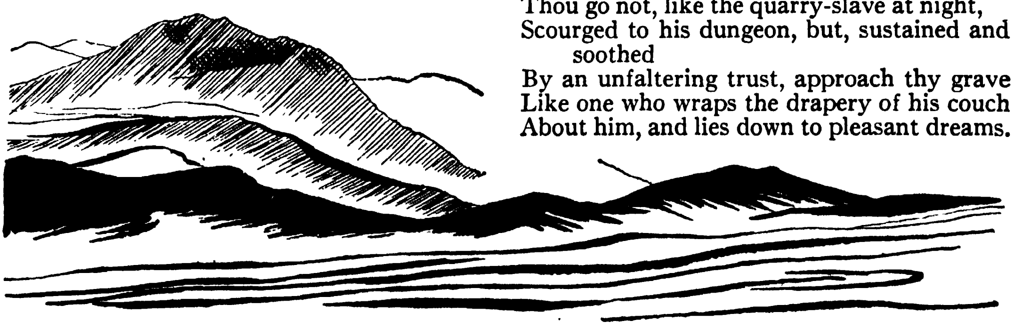
From Thanatopsis

By William Cullen Bryant (1794-1878)

Yet not to thine eternal resting-place
Shalt thou retire alone, nor couldst thou wish
Couch more magnificent. Thou shalt lie down
With patriarchs of the infant world—with kings,
The powerful of the earth—the wise, the good,
Fair forms, and hoary seers of ages past,
All in one mighty sepulchre. The hills
Rock-ribbed and ancient as the sun,—the vales
Stretching in pensive quietness between;
The venerable woods—rivers that move
In majesty, and the complaining brooks
That make the meadows green; and, poured round all,
Old Ocean's gray and melancholy waste,—
Are but the solemn decorations all
Of the great tomb of man. The golden sun,
The planets, all the infinite host of heaven,
Are shining on the sad abodes of death
Through the still lapse of ages. All that tread
The globe are but a handful to the tribes
That slumber in its bosom.—Take the wings
Of morning, pierce the Barcan wilderness,
Or lose thyself in the continuous woods
Where rolls the Oregon, and hears no sound,
Save his own dashings—yet the dead are there:
And millions in those solitudes, since first
The flight of years began, have laid them down
In their last sleep—the dead reign there alone.

So shalt thou rest—and what if thou withdraw
In silence from the living, and no friend
Take note of thy departure? All that breathe
Will share thy destiny. The gay will laugh
When thou art gone, the solemn brood of care
Plod on, and each one as before will chase
His favorite phantom; yet all these shall leave
Their mirth and their employments, and shall come
And make their bed with thee. As the long train
Of ages glides away, the sons of men—
The youth in life's fresh spring, and he who goes
In the full strength of years, matron and maid,
The speechless babe, and the gray-headed man—
Shall one by one be gathered to thy side,
By those, who in their turn shall follow them.

So live, that when thy summons comes to join
The innumerable caravan, which moves
To that mysterious realm, where each shall take
His chamber in the silent halls of death,
Thou go not, like the quarry-slave at night,
Scourged to his dungeon, but, sustained and soothed
By an unfaltering trust, approach thy grave
Like one who wraps the drapery of his couch
About him, and lies down to pleasant dreams.



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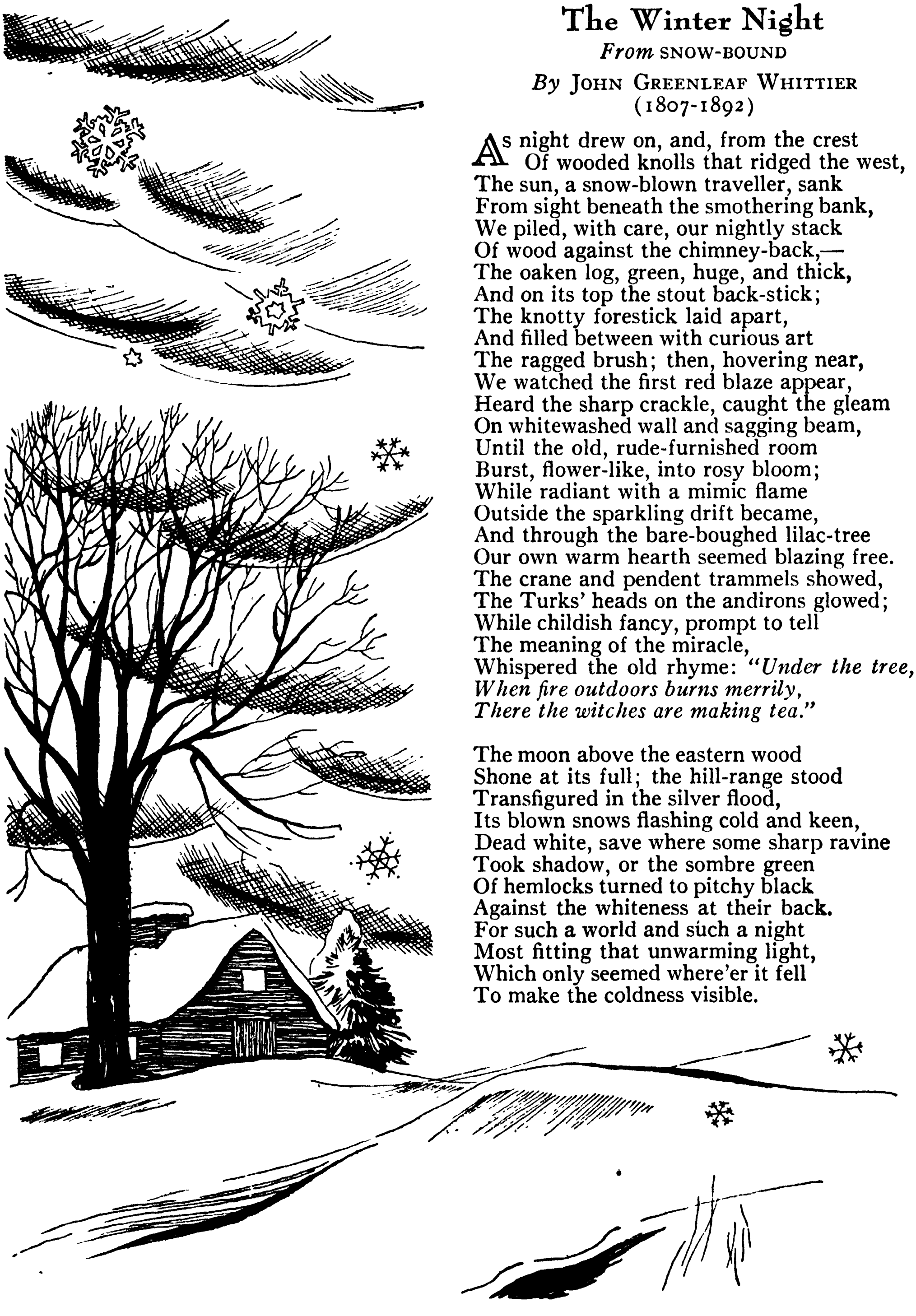
The Winter Night

From SNOW-BOUND

By JOHN GREENLEAF WHITTIER

(1807-1892)



As night drew on, and, from the crest
Of wooded knolls that ridged the west,
The sun, a snow-blown traveller, sank
From sight beneath the smothering bank,
We piled, with care, our nightly stack
Of wood against the chimney-back,—
The oaken log, green, huge, and thick,
And on its top the stout back-stick;
The knotty forestick laid apart,
And filled between with curious art
The ragged brush; then, hovering near,
We watched the first red blaze appear,
Heard the sharp crackle, caught the gleam
On whitewashed wall and sagging beam,
Until the old, rude-furnished room
Burst, flower-like, into rosy bloom;
While radiant with a mimic flame
Outside the sparkling drift became,
And through the bare-boughed lilac-tree
Our own warm hearth seemed blazing free.
The crane and pendent trammels showed,
The Turks' heads on the andirons glowed;
While childish fancy, prompt to tell
The meaning of the miracle,
Whispered the old rhyme: *"Under the tree,*
When fire outdoors burns merrily,
There the witches are making tea."

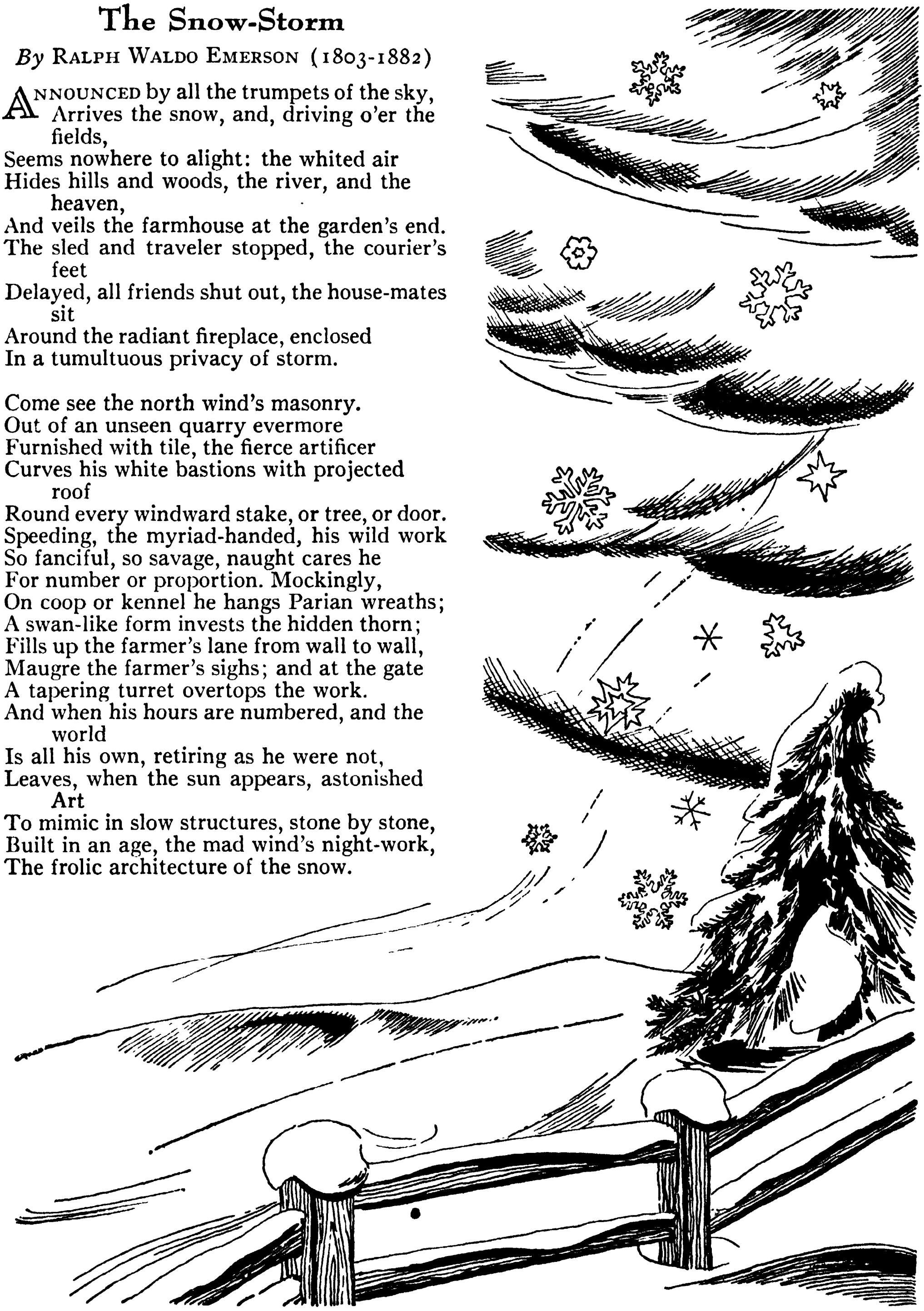
The moon above the eastern wood
Shone at its full; the hill-range stood
Transfigured in the silver flood,
Its blown snows flashing cold and keen,
Dead white, save where some sharp ravine
Took shadow, or the sombre green
Of hemlocks turned to pitchy black
Against the whiteness at their back.
For such a world and such a night
Most fitting that unwarming light,
Which only seemed where'er it fell
To make the coldness visible.

The Snow-Storm

By RALPH WALDO EMERSON (1803-1882)

ANNOUNCED by all the trumpets of the sky,
Arrives the snow, and, driving o'er the fields,
Seems nowhere to alight: the whited air
Hides hills and woods, the river, and the heaven,
And veils the farmhouse at the garden's end.
The sled and traveler stopped, the courier's feet
Delayed, all friends shut out, the house-mates sit
Around the radiant fireplace, enclosed
In a tumultuous privacy of storm.

Come see the north wind's masonry.
Out of an unseen quarry evermore
Furnished with tile, the fierce artificer
Curves his white bastions with projected roof
Round every windward stake, or tree, or door.
Speeding, the myriad-handed, his wild work
So fanciful, so savage, naught cares he
For number or proportion. Mockingly,
On coop or kennel he hangs Parian wreaths;
A swan-like form invests the hidden thorn;
Fills up the farmer's lane from wall to wall,
Maugre the farmer's sighs; and at the gate
A tapering turret overtops the work.
And when his hours are numbered, and the world
Is all his own, retiring as he were not,
Leaves, when the sun appears, astonished Art
To mimic in slow structures, stone by stone,
Built in an age, the mad wind's night-work,
The frolic architecture of the snow.



Hiawatha's Childhood

By Henry Wadsworth Longfellow
(1807-1882)

From THE SONG OF HIAWATHA

By the shores of Gitche Gumee,
By the shining Big-Sea-Water,
Stood the wigwam of Nokomis,
Daughter of the Moon, Nokomis.
Dark behind it rose the forest,
Rose the black and gloomy pine-trees,
Rose the firs with cones upon them;
Bright before it beat the water,
Beat the clear and sunny water,
Beat the shining Big-Sea-Water.
There the wrinkled old Nokomis
Nursed the little Hiawatha,
Rocked him in his linden cradle,
Bedded soft in moss and rushes,
Safely bound with reindeer sinews;
Stilled his fretful wail by saying,
"Hush! the Naked Bear will get thee!"
Lulled him into slumber, singing,
"Ewa-yea! my little owlet!
Who is this, that lights the wigwam?
With his great eyes lights the wigwam?
Ewa-yea! my little owlet!"

. . . .

At the door on summer evenings
Sat the little Hiawatha;
Heard the whispering of the pine-trees,
Heard the lapping of the waters,
Sounds of music, words of wonder;
"Minne-wawa!" said the pine-trees,
"Mudway-aushka!" said the water.
Saw the fire-fly, Wah-wah-taysee,
Flitting through the dusk of evening,
With the twinkle of its candle
Lighting up the brakes and bushes,
And he sang the song of children,
Sang the song Nokomis taught him:
"Wah-wah-taysee, little fire-fly,
Little, flitting, white-fire insect,
Little, dancing, white-fire creature,
Light me with your little candle,
Ere upon my bed I lay me,
Ere in sleep I close my eyelids!"

Saw the moon rise from the water,
Rippling, rounding from the water,
Saw the flecks and shadows on it,
Whispered, "What is that, Nokomis?"
And the good Nokomis answered:
"Once a warrior, very angry,
Seized his grandmother, and threw her
Up into the sky at midnight;
Right against the moon he threw her;
'Tis her body that you see there."
Saw the rainbow in the heaven,
In the eastern sky, the rainbow,
Whispered, "What is that, Nokomis?"
And the good Nokomis answered:
"'Tis the heaven of flowers you see there;
All the wild-flowers of the forest,
All the lilies of the prairie,
When on earth they fade and perish,
Blossom in that heaven above us."
When he heard the owls at midnight,
Hooting, laughing in the forest,
"What is that?" he cried in terror,
"What is that," he said, "Nokomis?"
And the good Nokomis answered:
"That is but the owl and owlet,
Talking in their native language,
Talking, scolding at each other."

. . . .

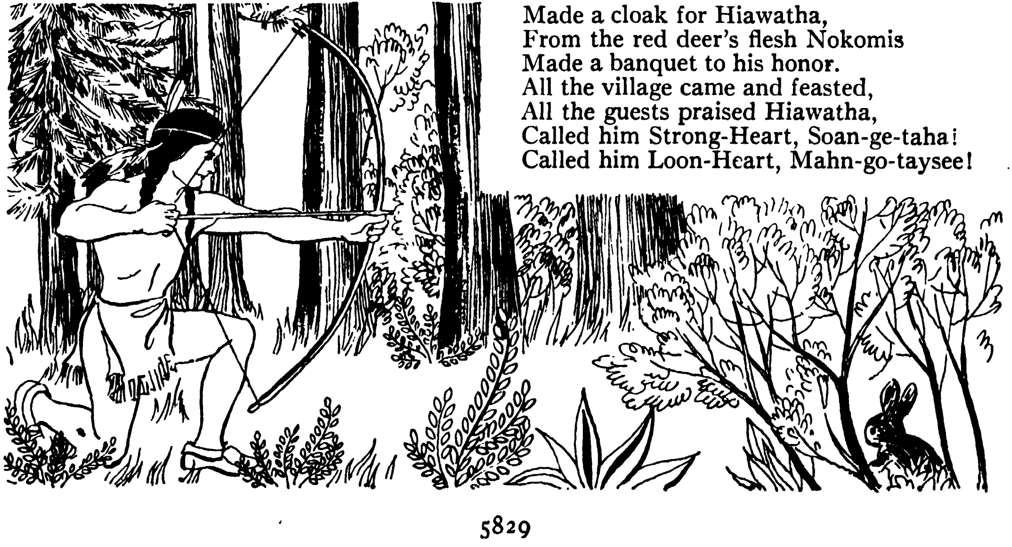
Then the little Hiawatha
Learned of every bird its language,
Learned their names and all their secrets,
How they built their nests in summer,
Where they hid themselves in winter,
Talked with them whene'er he met them,
Called them "Hiawatha's Chickens."

Of all beasts he learned the language,
Learned their names and all their secrets,
How the beavers built their lodges,
Where the squirrels hid their acorns,
How the reindeer ran so swiftly,
Why the rabbit was so timid,
Talked with them whene'er he met them,
Called them "Hiawatha's Brothers."

. . . .

Then Iagoo, the great boaster,
He the marvelous story-teller,
He the traveler and the talker,
He the friend of old Nokomis,
Made a bow for Hiawatha;
From a branch of ash he made it,
From an oak-bough made the arrows.
Tipped with flint, and winged with feathers,
And the cord he made of deer-skin.
Then he said to Hiawatha:
"Go, my son, into the forest,
Where the red deer herd together,
Kill for us a famous roebuck,
Kill for us a deer with antlers!"

Forth into the forest straightway
All alone walked Hiawatha
Proudly, with his bow and arrows;
And the birds sang round him, o'er him,
"Do not shoot us, Hiawatha!"
Up the oak-tree, close beside him,
Sprang the squirrel, Adjidaumo,
In and out among the branches,
Coughed and chattered from the oak-tree,
Laughed, and said between his laughing,
"Do not shoot me, Hiawatha!"
And the rabbit from his pathway
Leaped aside, and at a distance
Sat erect upon his haunches,
Half in fear and half in frolic,
Saying to the little hunter,
"Do not shoot me, Hiawatha!"
But he heeded not, nor heard them,
For his thoughts were with the red deer;
On their tracks his eyes were fastened,
Leading downward to the river,
To the ford across the river,
And as one in slumber walked he.
Hidden in the alder-bushes,
There he waited till the deer came,
Till he saw two antlers lifted,
Saw two eyes look from the thicket,
Saw two nostrils point to windward,
And a deer came down the pathway,
Flecked with leafy light and shadow.
And his heart within him fluttered,
Trembled like the leaves above him,
Like the birch-leaf palpitated,
As the deer came down the pathway.
Then, upon one knee uprising,
Hiawatha aimed an arrow;
Scarce a twig moved with his motion,
Scarce a leaf was stirred or rustled,
But the wary roebuck started,
Stamped with all his hoofs together,
Listened with one foot uplifted,
Leaped as if to meet the arrow;
Ah! the singing, fatal arrow,
Like a wasp it buzzed and stung him!
Dead he lay there in the forest,
By the ford across the river;
Beat his timid heart no longer,
But the heart of Hiawatha
Throbbed and shouted and exulted
As he bore the red deer homeward,
And Iagoo and Nokomis
Hailed his coming with applauses.
From the red deer's hide Nokomis
Made a cloak for Hiawatha,
From the red deer's flesh Nokomis
Made a banquet to his honor.
All the village came and feasted,
All the guests praised Hiawatha,
Called him Strong-Heart, Soan-ge-taha!
Called him Loon-Heart, Mahn-go-taysee!



Chartless*

By EMILY DICKINSON (1830-1886)

I NEVER saw a moor,
I never saw the sea;
Yet know I how the heather looks,
And what a wave must be.

I never spoke with God,
Nor visited in heaven;
Yet certain am I of the spot
As if the chart were given.

The Fountain

By JAMES RUSSELL LOWELL (1819-1891)

INTO the sunshine,
Full of the light,
Leaping and flashing
From morn till night!

Into the moonlight,
Whiter than snow,
Waving so flower-like
When the winds blow!

Into the starlight,
Rushing in spray,
Happy at midnight,
Happy by day!

Ever in motion,
Blithesome and cheery,
Still climbing heavenward,
Never aweary;

Glad of all weathers,
Still seeming best,
Upward or downward
Motion thy rest;

Full of a nature
Nothing can tame,
Changed every moment,
Ever the same;

Ceaseless aspiring,
Ceaseless content,
Darkness or sunshine
Thy element;

Glorious fountain!
Let my heart be
Fresh, cheerful, constant,
Upward like thee!

Beauty Crowds Me*

By EMILY DICKINSON (1830-1886)

BEAUTY crowds me till I die,
Beauty, mercy have on me!
Yet if I expire today
Let it be in sight of thee!

Eldorado

By EDGAR ALLAN POE (1809-1849)

GAILY bedight,
A gallant knight
In sunshine and in shadow
Had journeyed long,
Singing a song,
In search of Eldorado.

But he grew old—
This knight so bold—
And o'er his heart a shadow
Fell, as he found
No spot of ground
That looked like Eldorado.

And, as his strength
Failed him at length,
He met a pilgrim shadow:
"Shadow," said he,
"Where can it be—
This land of Eldorado?"

"Over the mountains
Of the moon,
Down the valley of the Shadow
Ride, boldly ride,"
The shade replied,
"If you seek for Eldorado!"

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THE NEXT POEMS ARE ON PAGE 6098.

Courtesy, Royal Canadian Mounted Police

Members of the Royal Canadian Mounted Police leaving Buckingham Palace after presentation of medals.

THE ROYAL CANADIAN MOUNTED POLICE

THE Royal Canadian Mounted Police—first known as the Northwest Mounted Police—were organized in the year 1873. Before that, the boundless prairies of British North America for centuries had been inhabited by Indian tribes who lived upon the buffalo, and were prosperous and powerful. After the white men came to the continent, the British fur companies kept liquor away from the Indians, and agreed with them comfortably.

But from 1870 onward a series of great changes befell the land, most of them misfortunes to the Indians. First of all, whiskey-traders from across the southern border began to move through the country, and their influence threatened to ruin the Indians. Then, in the strangest manner, the buffalo, their chief source of food, began to die out, and the Indians were left destitute. Almost at the same time white men came in to possess the land, first as ranchers with thousands upon thousands of cattle which the Indians longed to eat in place of the buffalo; then as engineers and workmen building a great railway through the prairies; then as farmers, and lastly as dwellers in towns and cities.

Every one of these changes was terribly hard upon the Indians. Yet there was no warfare between them and the whites, and to-day they are living peacefully in the country. Why was there so little trouble? Because the Canadian Government treated the Indians, on the whole, justly, and because the policy of the Government was enforced by the Mounted Police.

The Dominion of Canada acquired possession of the Northwest Territories in 1869. Very soon it was found that unless the whiskey traders could be driven out there would be so much trouble with the Indians that settlement or proper trade by white men would be impossible.

The Northwest Mounted Police were organized, and in 1874 they marched across the prairies to the Rocky Mountains. It happened that about twenty-five years earlier a regiment of British infantry had been stationed for a while in the Red River settlement (now Manitoba), and the Indians not only had liked them, but also had associated the red coat with British soldiers. They were aware that their fellow-Indians in the United States had frequently been on bad terms with the Americans, whose soldiers wore blue. For this reason the Mounted Police were uniformed in red, and at the first glance the Indians recognized them as a British force. The whiskey-traders were promptly driven away, and the Police at once made the Indians see that where they executed the law justice would be done.

The Blackfeet were a very powerful tribe in what now is southern Alberta. One of their leading chiefs, Crowfoot, after seeing two of his men tried for an offense with which they had been charged, said: "This is a place where the forked tongue is made straight. When my people do wrong they shall come here." The Police became such good friends with the Indians, while making them strictly obey the law, that in 1877, three years after their arrival in the country, when it was proposed to conclude a treaty by which the Indians would agree to settlement by the whites, the Indians consented. Chief Crowfoot in his speech to his people, urging them to agree, said: "The Police have protected us as the feathers of a bird protect it from the frosts of winter."

Chief Crowfoot, Blackfeet Indian, a good friend to the "Mounties."

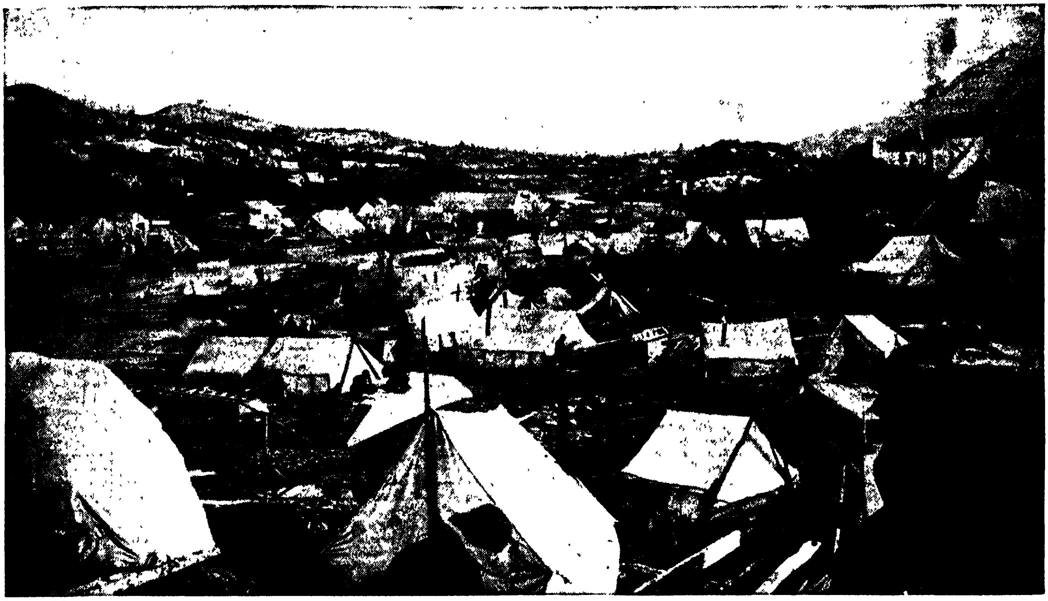
Soon afterward the great calamity of the disappearance of the buffalo befell the Indians, but the Government gave them help, and the Mounted Police kept them from doing what starving savages would do naturally—go raiding against people who had food. As white settlers came in, the Police made them, too, obey the laws, and the Canadian Northwest always was orderly.

In 1898 gold was discovered in the Yukon Territory, and great numbers of people rushed to the diggings. With the genuine miners went crowds of gamblers, thieves and other bad characters to prey upon the men who did the work. In some of the American towns through which the gold-seekers passed, vice, crime and disorder were serious problems. But Mounted Police had been stationed in the Yukon before the great gold discoveries were made, and from the beginning of the rush they kept order, so that Dawson and other towns in the mining region always were quiet, law-abiding and safe. When a man was found carrying a revolver in Dawson he was given a penalty of a month "on the wood-pile" without the option of a fine; so that the second-hand stores were full of weapons, and pistols were the only things cheap in Dawson.

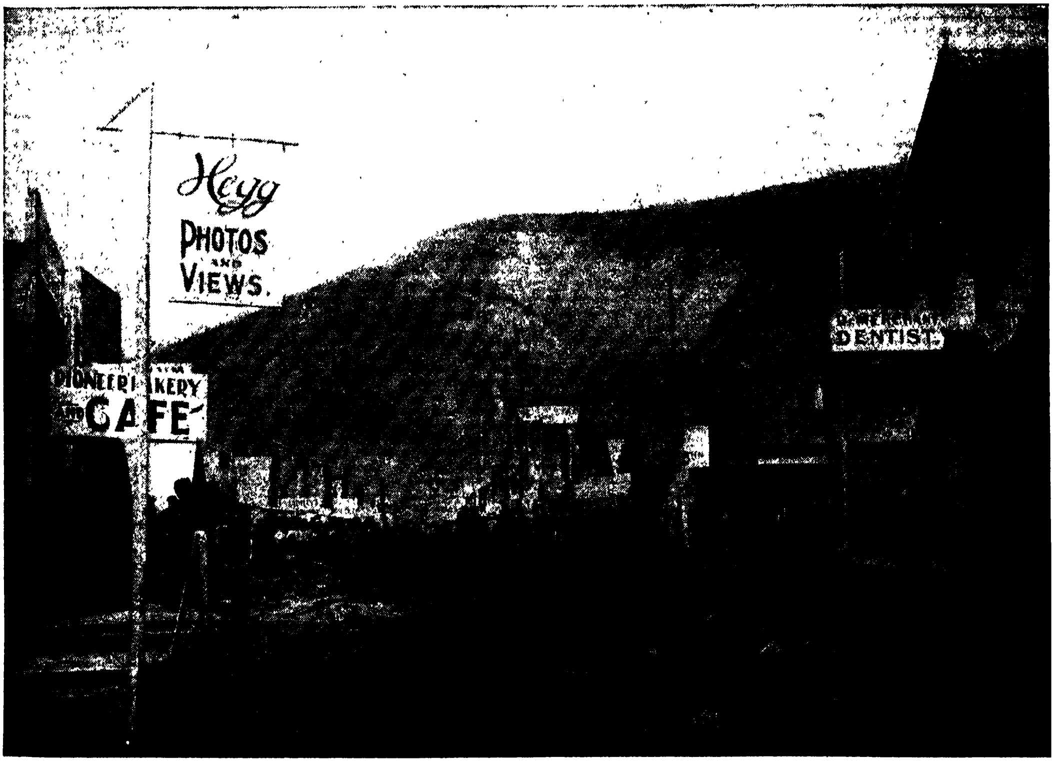
The trails and creeks where the gold was found were watched, and the prospectors and miners protected. Every boat on the river was numbered, so that missing parties could be traced. A few men were murdered on the long and lonely trails, but in each case the Mounted Police followed every clue and in the end captured the slayers. One murderer was traced from the Yukon through the United States, to Mexico, and was brought back by way of Jamaica and Halifax. So far as is known, no murder occurred in the Yukon without the perpetrator's being discovered, arrested and convicted.

In addition to enforcing obedience to the

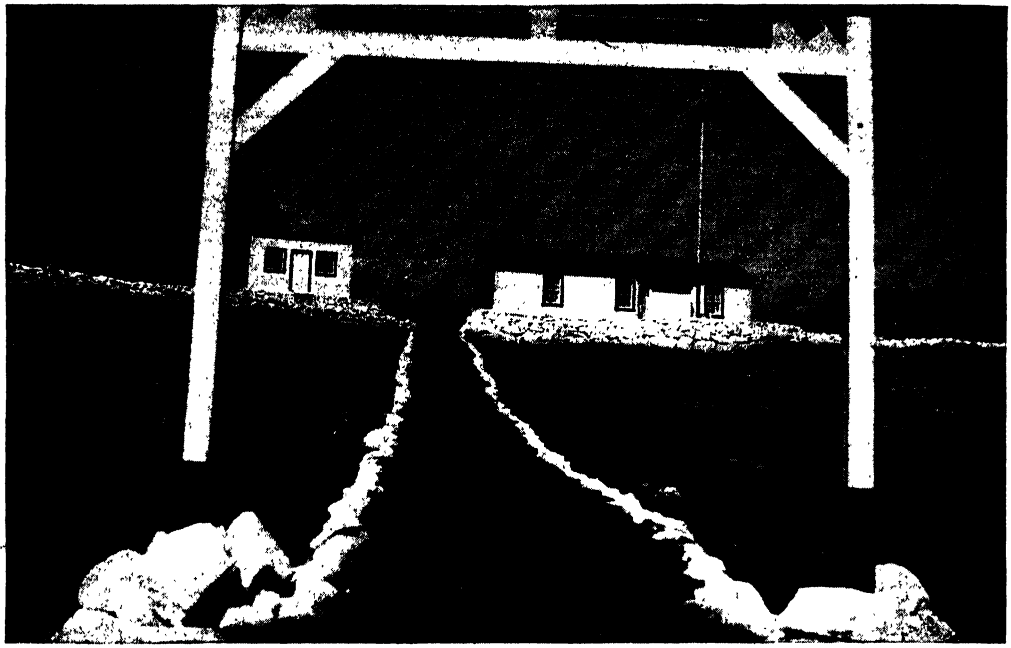
THE GOLD RUSH DAYS OF NINETY-EIGHT



A camp of tents on the way to Dawson in the Northwest Territories, in the gold rush of 1898.



Dawson "City," in 1898, two years after gold had been discovered on Bonanza Creek, twelve miles away.



A lonely outpost station showing dwelling and guard room. Nowadays the force has three times as many motor vehicles as saddle horses, though horses are still used, and in the far north, sleigh dogs.

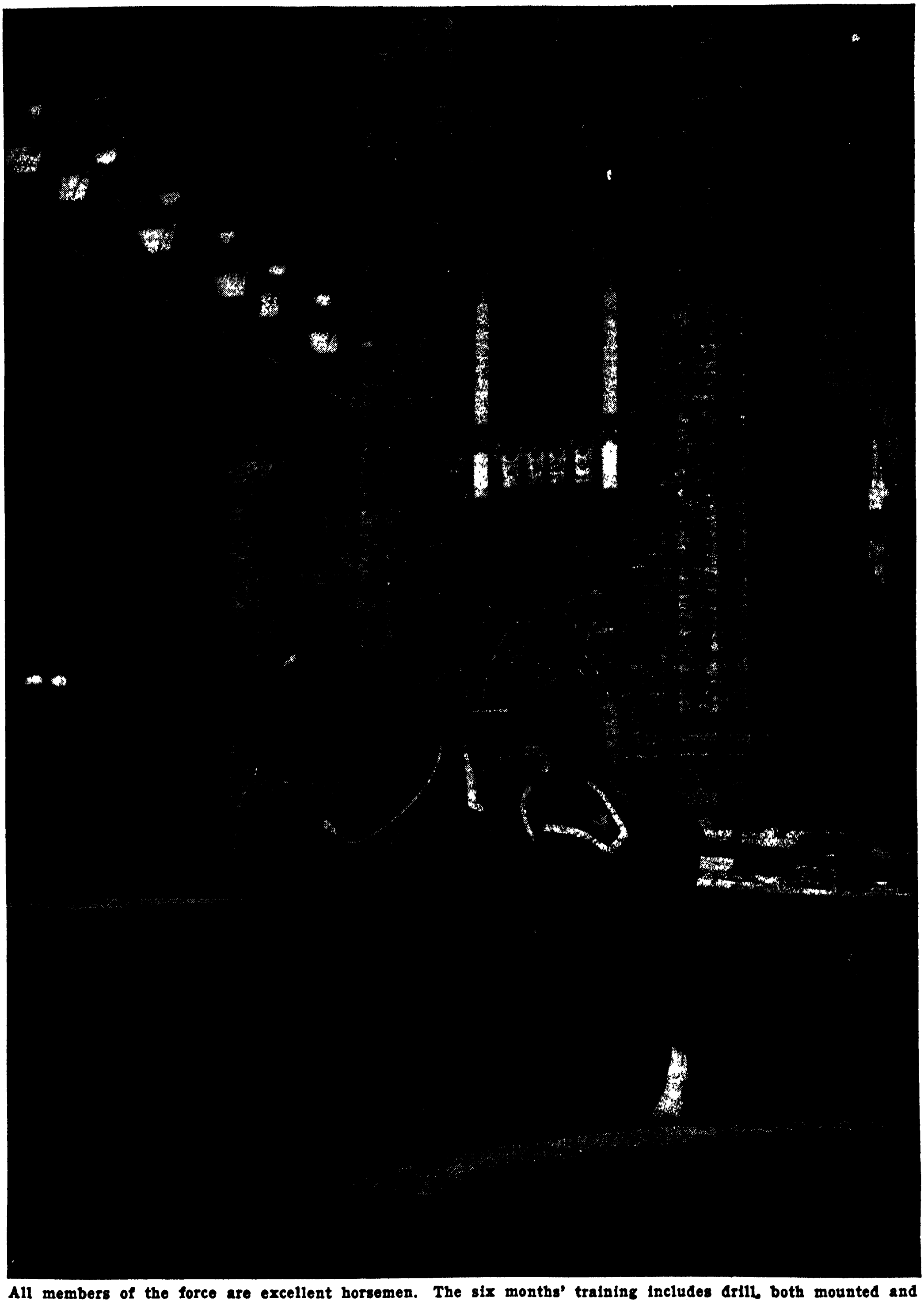
law, the Mounted Police have performed an immense number of other duties. To this day in the Yukon they discharge nearly all the functions of government, from enforcing town by-laws to acting as postmaster and customs officers. One curious piece of work has become noticeable of late. Many prospectors have been in the country since the first discoveries of gold, over forty years ago, and have become old and feeble. In the winter the Police send patrols through the wilds to see that these men, as well as the scattered trappers, are safe. This sort of duty is familiar to the Mounted Police, for when the prairies were filling up with farmers it was necessary to protect scattered settlers from the dangers of winter, and after a series of blizzards fur-clad horsemen would make long patrols to see that lonely families had sufficient food and fuel and were not suffering from illness. To-day the country where this was done has over a million and a half inhabitants and is one of the greatest grain-growing districts in the world.

A great change came in 1920. The Force was made an all-Canadian one. In the beginning it was called the Northwest Mounted Police and had charge of the police work in what was called then the Northwest Territories—the region which lay between Manitoba on the east and British Columbia on the west, and north of the 49th parallel, the boundary between Canada and the United States; the region now occupied by the provinces of Alberta and Saskatchewan.

In 1904 the work done there and in the Yukon was recognized by an honor greatly prized by British soldiers: they were given by the King the title of "Royal," and for the next sixteen years they were the Royal Northwest Mounted Police. As the years went on their duties changed. At first they had been a police of the wilderness, keeping Indians from fighting each other and bad white men and Indians from stealing horses and cattle. Then, as villages and towns sprang up and farmers began to grow grain, the "Mounties" had to "maintain the right" (the motto of the corps) in town and countryside. They were no longer a wilderness force.

As towns like Calgary, Edmonton, Regina and Saskatoon grew larger, they set up their own police forces. The Mounted Police thus remained long, on the whole, a rural constabulary, dealing with the sort of crimes that are to be found in country districts, and in the Yukon, of course, dealing with problems of law enforcement in a mining and trading community. Then, about 1905,

ON GUARD, AT PARLIAMENT HILL, OTTAWA



All members of the force are excellent horsemen. The six months' training includes drill, both mounted and dismounted, wrestling, boxing, jiu-jitsu, police duties, court procedure and other subjects.

In winter uniform, with fur coat and cap.

they began to pay attention to the Arctic regions, as it became known that whalers were visiting them and injuring the Eskimos, even as the whiskey-traders had corrupted the Indians in 1870. There were trading posts on the Mackenzie River and at Herschel Island as early as 1903.

The first World War brought other changes. After a period, during which the Force was kept in Western Canada to insure order, it was allowed to furnish troops for the front, and two squadrons of Royal Northwest Mounted Police went overseas, one to France and one to Siberia. This meant giving up the rural police work which had been done for so long. The new provinces of Alberta and Saskatchewan took over their own policing and formed provincial forces of their own. Further than that, the Dominion authorities had been convinced for a long time that they needed a strong police force of their own for a great many different duties.

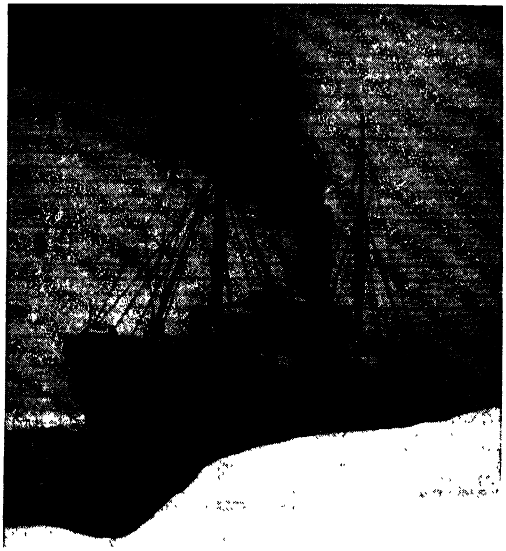
THE ROYAL CANADIAN MOUNTED POLICE ENFORCE THE FEDERAL LAW

At the close of the war, an important change was made; a new chapter began in the history of the "Mounties." Up to this time the Dominion of Canada had been maintaining two separate police forces. In Western Canada there were the Royal Northwest Mounted Police. In Eastern Canada was another force, the Dominion Police, nearly all of whose men were in Ottawa, where they guarded Government buildings, tracked down counterfeiters, managed a Fingerprint Bureau, and also performed several other important duties. In 1919 it was decided that the Royal Northwest Mounted Police should absorb the Dominion Police and, under the name of the Royal Canadian Mounted Police, should do the police work needed by the Dominion Government all over the country. The new system came into existence very early in 1920.

THE "MOUNTIES" ABSORB MANY PROVINCIAL POLICE FORCES

In 1928 the Saskatchewan Provincial Police were absorbed by the Royal Canadian Mounted Police, which again accepted the duty of enforcing the provincial statutes. Since that time the Force has assumed even greater responsibilities by taking over police duties in Alberta, Manitoba, New Brunswick, Nova Scotia and Prince Edward Island. Any province may enter into an agreement with the Dominion Government for the services of the Royal Canadian Mounted Police, to enforce provincial law, upon payment for these services. The Preventive Service of the Department of National Revenue was also taken over in 1932, but the Marine Section of that service, at the outbreak of World War II, was transferred to the Department of National Defence.

The Federal statutes, of course, are enforced by the Royal Canadian Mounted Police throughout the Dominion, even where provincial forces still exist. There are a great many Federal laws which require inspection and enforcement. To take one in-



The Hudson Bay Company's R.M.S. Nascopie, often carries Royal Canadian Mounted Police to distant stations.

stance, by the Explosive Act people who keep gunpowder, dynamite and similar explosives for sale or use must store them carefully, and it is necessary to visit these people to see that they obey the regulations. To take another instance, fishermen must refrain from catching fish, oysters, lobsters, and the like in certain seasons and of a certain size, and for their own good careless or greedy fishermen must be watched and made to obey. To take yet another example, airplanes which fly over Canadian soil must observe certain conditions, and here again it is necessary to have someone to enforce these important rules strictly.

The list of duties is very long, and all over Canada detachments of the Royal Canadian Mounted Police are "maintaining the right" by catching smugglers, detecting counterfeiters, discovering and arresting people who sell narcotic drugs, ferreting out illicit stills, protecting migratory birds, and doing a thousand other things, sometimes difficult and tiresome, sometimes interesting. They still keep in close touch with the Indians with whom their relations nearly always are exceedingly friendly; they still do an immense amount of work in the Yukon; and they also have a new field of adventure in the Arctic, where new posts are being opened every year, and where an ever growing proportion of the Force is stationed.

In six of the nine provinces the "Mounties" enforce provincial as well as Federal law. In the Yukon and Northwest Territories they enforce all law. Members of the Force stationed there often hold offices, such as Justice of the Peace, Postmaster and Coroner. Recruits receive some military as well as police training. Discipline is strict and orders of superiors must be obeyed instantly.

It is common knowledge that the Force is highly regarded. People outside as well as inside of Canada feel that it discharges its duties honestly, fearlessly, impartially; that its men are courteous as well as inflexible, doing their duty without being rude or overbearing; that it is greatly feared by evil-

Eskimos at Port Burwell. Here the Royal Canadian Mounted Police maintain the white man's law.

The Force has a number of police dogs which help to find lost persons and to pursue fugitives from justice. Here is "Tuff." He has just found a little girl who was lost, and is giving tongue, to guide searchers to her.

doers, who know that they will be followed patiently and unrelentingly so that a legend —which is only a legend—has sprung up that its motto is: "Get your man." All these qualities rest upon discipline—the strict but sympathetic discipline of the British Army, which succeeds in uniting obedience and mutual consideration, so that all ranks are permeated with the sentiments of honor and responsibility.

It is a rather young force, for most of the recruits are men in their twenties, and during recent years a definite effort has been made to secure well educated young men for the Force. The standard of education now required for entrance into the Force is much higher than formerly.

Since the outbreak of war, in September, 1939, the Force has had a tremendous increase in responsibilities and duties, and its strength to-day is over 4,500 officers and men, which includes a considerable number of Veterans who guard bridges, dock yards, buildings, and so forth.

At Regina, Saskatchewan, and Rockcliffe, Ontario, there are Police Training Colleges which have scientific laboratories to assist in the solution of crime. The training given to a member of the Royal Canadian Mounted Police to-day, in the use of up-to-date methods and aids in the solution of crime is equal to training given anywhere in the world.

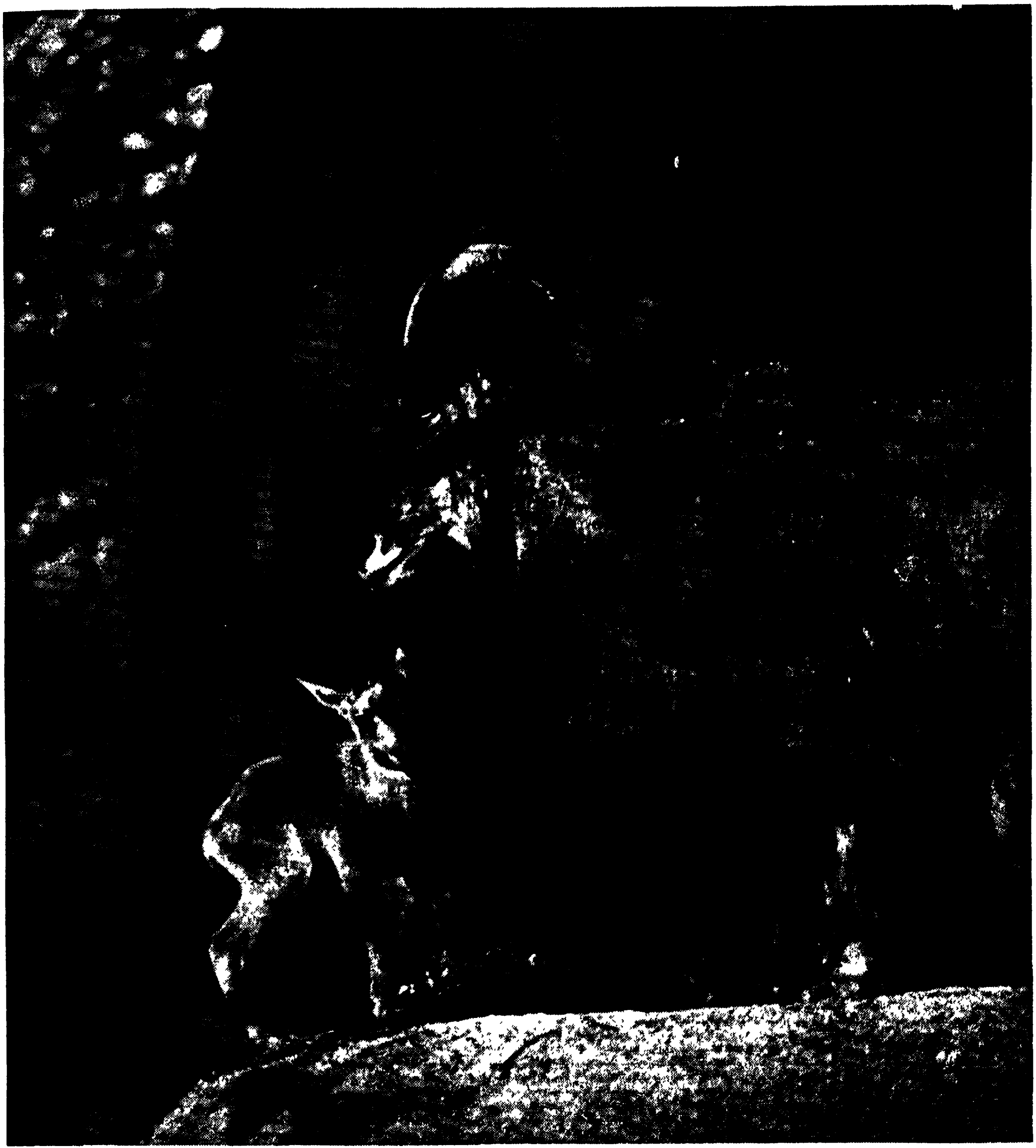
The Force still patrols the remote areas in the Canadian Arctic, the Northwest Territories and the Yukon, and the relations with the Eskimo, in these regions, are as friendly as those with Indians.

The Royal Canadian Mounted Police have a very strongly built auxiliary schooner, the St. Roch. Since 1928, she has delivered supplies to the Mounted Police posts in the Arctic regions. In 1940-42 she made a voyage from Vancouver, British Columbia, to North Sydney, Nova Scotia, by way of the Northwest Passage, and in 1944 went from Halifax to Vancouver by the Northwest Passage in a little more than eighty days—the only vessel to navigate this passage both ways.

Until the outbreak of World War II, the Royal Canadian Mounted Police had an Aviation Section, but as soon as war broke out all members who were trained in the use of aircraft were transferred to the Royal Canadian Air Force. The Force still retains some of the aircraft formerly used, and important journeys have been made into the Northwest Territories, making long patrols, in certain cases, unnecessary.

One other aspect of the Force's work should also be mentioned, namely the use of trained police dogs. During recent years the Force has taken considerable pains to secure and train suitable dogs for use in finding lost children and other persons, in picking up the trail of fugitives from justice, and even in finding caches (hidden stores) of smuggled liquor. These dogs have carried out a most valuable work and have become very popular in the Force.

Article and pictures by Commissioner S. T. Wood, Royal Canadian Mounted Police, Ottawa.



St. Louis Zoological Gardens

In two or three years this lovably awkward lamb of a Barbary sheep will grow to be as large as its mother.

Why Do Animals Grow Up So Soon?

A FLY is born full-grown. It never gets any bigger. A puppy reaches full growth in about a year. A few breeds of dogs take a little longer to grow up, but all of them are adult dogs before the age of three. A human being at three years is still little more than a baby. Why do animals grow up so soon? There are several things to note about this.

One fact is that there is generally a certain proportion between a creature's length of life and the time it takes to grow to full size. As we should expect, the growing-up process is quicker in the case of an animal, such as a dog, that is very old at fifteen

years, than in the case of a man who may live to be eighty or more years old. The proportion in growth between dogs and humans is said to be one to seven. That is, a dog at fourteen years is as "old" physically as a man at ninety-eight.

Another fact is that in the highest types of animals the young creatures are much more dependent upon their mothers, and for a longer time, than the lower animals. This is true if we compare the lives of a hen, which is old at fourteen years, with that of an elephant which may live for a hundred years. The chicken leaves its mother's side and is able to take care of itself after a few weeks. The young elephant is a baby living on milk for two years and remains under its mother's care for at least two more years. Not until it is around twenty years old is an elephant full-grown.

This may suggest that there is some relation between the growing body and the growing brain. The creature with more brain develops more slowly. A hen's brain is of a low order. A hen lives largely by instinct. It seems to have some memory of the person who feeds it but most hens can be taught very little.

The elephant is one of the most teachable of animals. Its brain is not large, in comparison with its body, but its memory is good and the animal learns new skills quickly and often seems to reason. The elephant's brain, in other words, is more complicated than that of the hen. The hen grows up quickly because it does not do so much growing up as the elephant.

Size does not count, of course, in this scale, but complexity does. So it seems that the animals with more complicated bodies and brains develop more slowly, are dependent longer upon their mothers, are at their prime for a longer time and go more slowly down the hill toward old age than do creatures with simpler systems.

HOW CAN A DONKEY EAT A THISTLE, THORNS AND ALL?

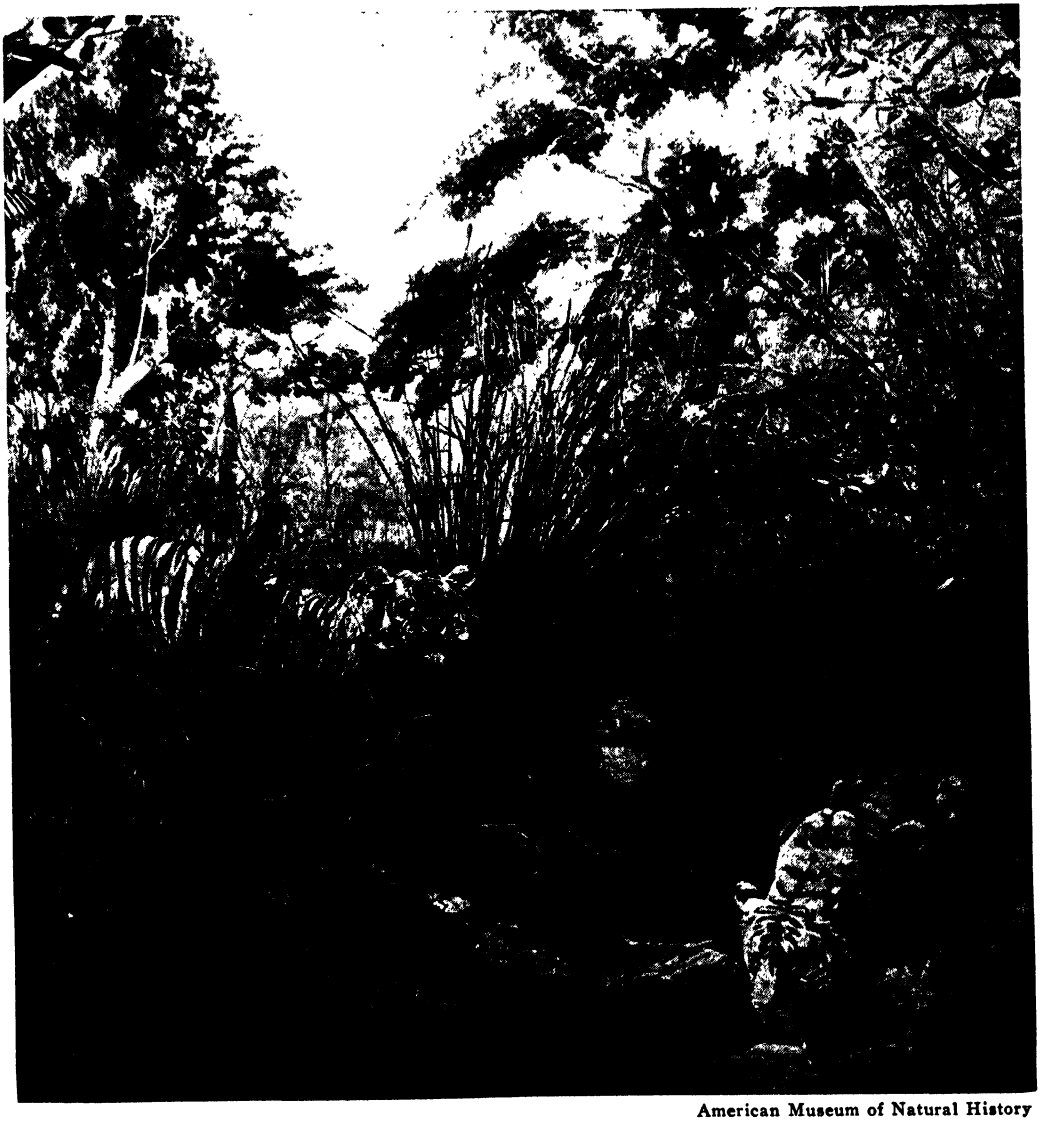
The inside of the mouth in animals differs widely according to the kind of food each animal lives on. In your own mouth the lining is quite soft and easily injured. In some animals the membrane that lines the mouth is extremely tough, and is covered with thick scales, enabling the creature to crush foods that would injure a tender mouth. This is the case, to a certain extent, in cattle and in all animals that feed on hard kinds of grass. The donkey's mouth is an example of one with a tough lining. Each kind of animal seems to know, by some instinct, what sorts of food it can eat safely; and animals with tender mouths would reject such food as thistles and thorns.

WHY IS A TIGER STRIPED?

The stripes on the tiger's coat are useful to him in a very special way. If tigers had not been so marked they would probably have died out long ago. As the beast glides through the jungle in search of smaller animals for food, its stripes blend with the grasses and stems of other plants, concealing it from its prey until it is ready to pounce. The protective coloring also hides the tiger from the eyes of its own enemies.

Of course, if an animal can not obtain food or has no protection against its enemies, it soon dies. So we have tigers today because nature gave them striped coats.

The leopard, haunting forests dappled with sunlight, is protected in much the same way by its spotted coat. The arctic fox and the polar bear have white coats that can scarcely be seen against the snow. The stoat has a brown coat in summer, when the earth is brown, and white fur when the earth is snow-covered. The chameleon, a small lizard, is able to change its color to that of the article on which it rests!



American Museum of Natural History

As one tiger drinks, a companion keeps guard, hidden where its stripes blend with the narrow spears of grass.

DO ANIMALS KNOW WHEN THEY ARE BEING TREATED KINDLY?

Not even the wisest man can tell you how much animals know and how much they do not know. It is even more difficult to say how much they can appreciate; but we do know that all the animals that man makes use of, or lives much with, can feel pain very readily, and are capable of great suffering.

But whether animals appreciate kindness intelligently or not, it makes a very great difference to the human being how he treats his animals. Any act of cruelty or unkindness, even to an animal, is a flaw in a human being's character. This is one of the most important things we have to learn. When we are cruel or unkind we harm ourselves.

WHAT HAPPENS INSIDE A CAT WHEN IT PURRS?

The noise a cat makes when it purrs is really a kind of talking, for it tells you that the cat has a certain kind of feeling. It feels pleased and happy, and it says so in its own way. If you put your hand on it when it purrs you can feel its whole body vibrating, or trembling. When anyone speaks or sings —especially if he is a man with a voice low in pitch—if you put your hand on his chest you can feel him vibrate, or tremble, just like the cat. In the case of the man we know that it is the vocal chords in his throat that he has set trembling, and they have set the whole of his chest trembling.

HOW LONG DO ANIMALS LIVE?

We can not give exact figures about the age of animals as we can about the age of men and women.

We know the age to which men and women live, because the date of their birth is entered in an official register, and the date of their death also is recorded. Famous animals that are kept by men are registered in books kept for the purpose, so we know the age of prize horses, cattle and so on. But if they remained in a wild state they might live longer. Too, many animals live and die in the wilds so that no records can be made of their length of life.

The prize for the land animals has to be given to the tortoise. This animal is believed to live, under favorable conditions, for between 300 and 400 years. The crocodile, given fair play in its native wilds, can live for 300 years.

It takes an elephant a long time to grow up, and it takes him a long time to wear out. Well treated, he should live to be a hundred. That is the age to which the eagle is supposed to live, but some people put the age he may reach at 200 years. Little is known about the age to which whales live, for they are seldom, if ever, kept or bred in captivity. They were once believed to reach 500 and even 1,000 years, but 100 years seems a more likely span.

In the following tables the extreme ages of animals like the whale and eagle and tortoise are not given. You may have known of a dog that lived to the fine old age of twenty, though we give fifteen in our table. Such a case is very rare, though not unheard of.

THE NUMBER OF YEARS SOME ANIMALS LIVE

Rabbit	5	Horse	30
Sheep	12	Camel	40
Cat	13	Lion	40
Dog	15	Elephant	100
Goat	15	Whale	100
Cow	25	Crocodile	300
Pig	25	Tortoise	350

THE NUMBER OF YEARS SOME BIRDS LIVE

Wren	3	Canary	24
Thrush	10	Crane	24
Robin	12	Peacock	24
Blackbird	12	Skylark	30
Hen	14	Goose	50
Goldfinch	15	Pelican	50
Partridge	15	Parrot	60
Pheasant	15	Heron	60
Lark	18	Crow	100
Nightingale	18	Swan	100
Pigeon	20	Eagle	100

Authorities disagree about these figures. There are no exact records.

ARE ALL ANIMALS BLIND AT BIRTH?

It is not quite true that all animals are born blind, but it is true that most of the mammals, when they are newly born, do not at once begin to use their eyes. The eyes themselves are there, however, fully developed and ready to be used for seeing as soon as they have become accustomed to the strong light. The young of wild animals are born in a nest selected by the mother. This is generally placed in some dark and secluded place to which very little light gains access. The young animals can open and shut their eyes in their dim home. When they begin to move and gradually come into light, the eyes also gradually become used to that light, so that they are perfectly able to see by the time they require their sight.

Snyder from Monkmeyer

It's weight-taking day in school—the taller children should weigh more than the little girl on the scale.

HOW MUCH SHOULD YOU WEIGH?

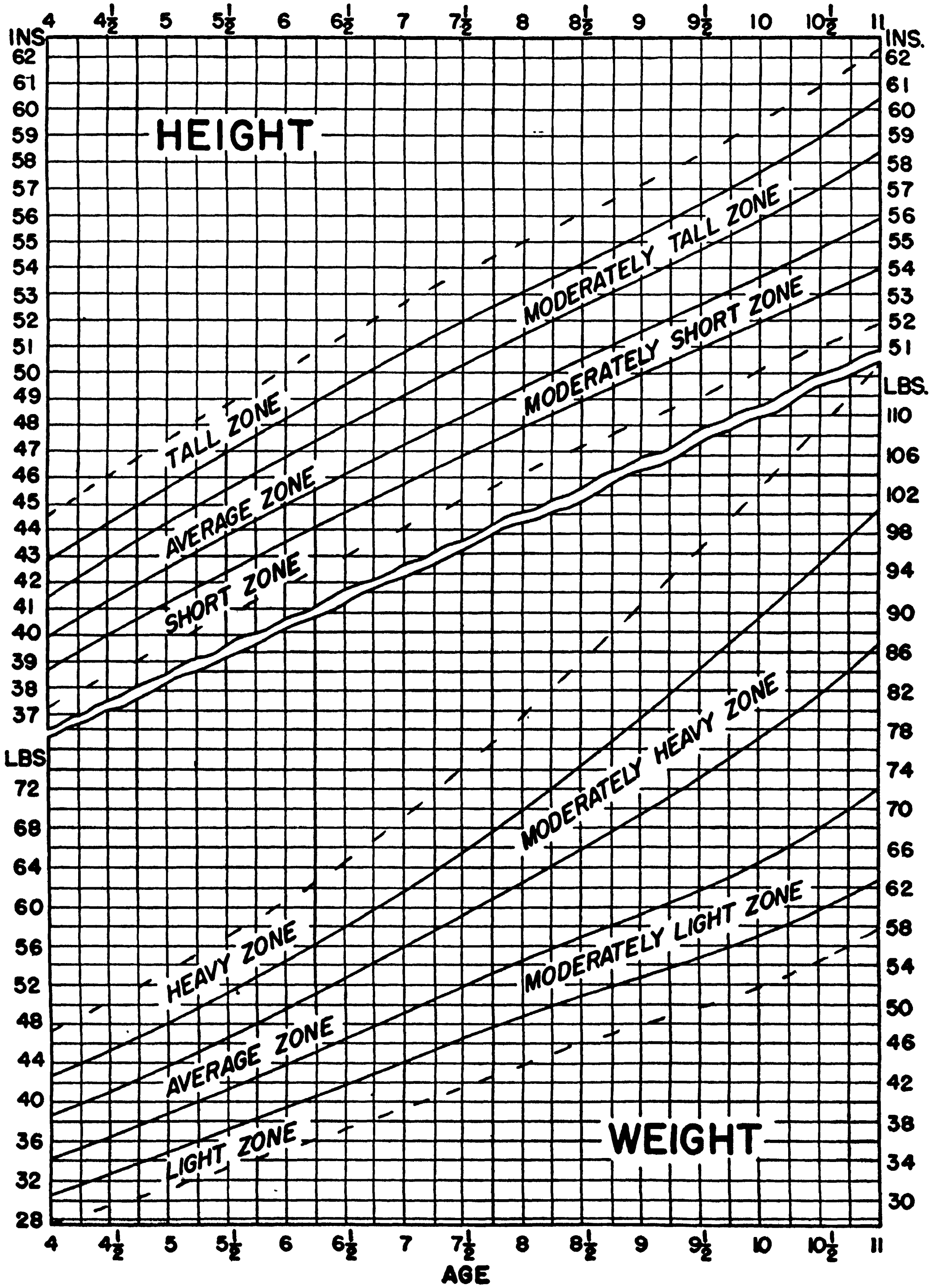
While what you should weigh is related to your height and age, there are as many variations in rate of growth and bodily structure as there are children. One child may spurt ahead while another slows up for a period, and yet both children be perfectly healthy. For this reason, most schools today have discarded the old tables that gave exact weights for every year.

Instead, measurements are taken at regular intervals and noted on charts like those on the following pages. The chief value of these charts is that they show gain or loss in weight, one of the most important indications of our state of health. Loss in a child, of course, is a warning signal.

Let us suppose that we are to begin a record for a little girl named Betty Hopkins. She is just 7 years old and is 48 inches tall and weighs 52 pounds. To mark her height, first find age 7 along the *top* of the chart for girls. Then locate 48 inches along the *upper* left-hand margin. Put a dot under the 7 and opposite 48. Just above this dot write "48."

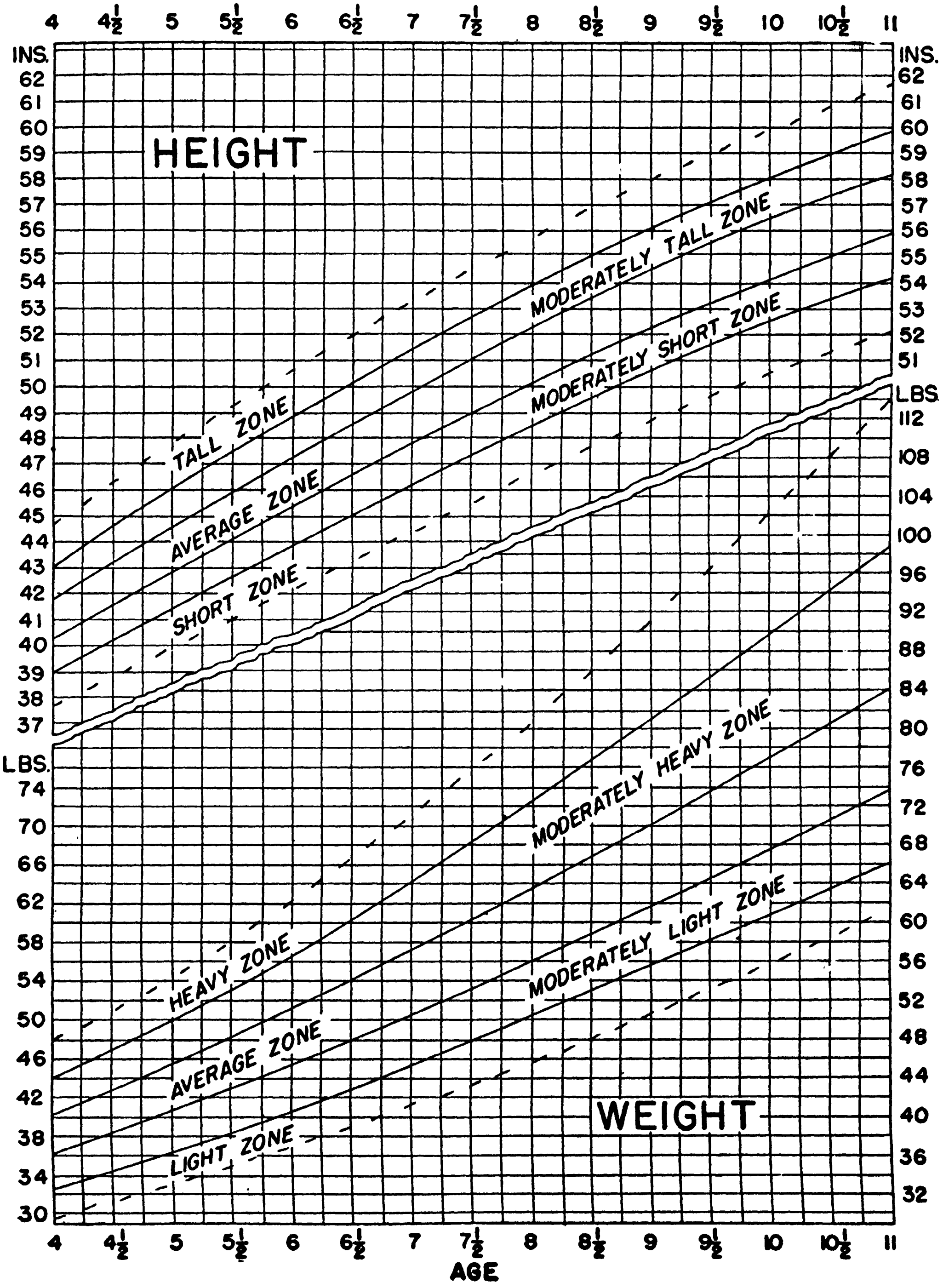
To make the record of Betty's weight, find

HEIGHT AND WEIGHT CHART FOR GIRLS



American Medical Association

HEIGHT AND WEIGHT CHART FOR BOYS



American Medical Association

age 7 along the *bottom* of the chart. Locate 52 pounds along the *lower* left-hand margin. Make a dot above the 7 and opposite 52. Just below this dot write "52."

The chart is so arranged that there is an "age" line for every three months; and as we note Betty's weight and height when she is 7¼, 7½ years old and so on, a line connecting the set of dots for height, and another line connecting those for weight, show her rate of growth at a glance. She is a healthy little girl, of average height and weight, and so the line will probably continue to curve upward in the "average zone."

WHAT DOES BIRTHRIGHT MEAN?

In nearly every part of the world, at one time or another, alike among savages and among civilized people, the eldest son had special rights and privileges over the others. He inherited most or all of his father's property, and had a special right to his father's title and position, whether as chief of a savage tribe or as a duke or king, or as holding some other title or dignity.

This right of the first-born was called his birthright, and the Bible story of Esau and Jacob is sufficient to tell us how old this custom is. The right of the first-born, still in vogue to some small extent in a few European countries, is called *primogeniture.* In most countries this law of birthright has been abolished, and sons inherit equally and have equal rights. France led the way in this respect. In the United States and Canada there is no law of primogeniture.

DO WE GROW AS MUCH ONE YEAR AS ANOTHER?

No. For one thing, whenever we have an illness our growth is affected—usually it is lessened, but sometimes it may be increased. But even if we have no illness, our rate of growth varies. Both boys and girls, but especially boys, grow much more from about fourteen to seventeen than at other times. Growth in height during that period depends almost entirely on the lengthening of the bones of the legs; and it is the difference in the length of the legs that makes the difference in height. That is why we can not tell how much people differ in height when they are all sitting down. The bones of the legs grow in length by the making of new bone at certain places near their ends. Some people do not grow after eighteen. Some grow more slowly after seventeen or eighteen, but continue to grow for several years.

ARE WE TALLER IN THE MORNING THAN AT NIGHT?

Perhaps there is a very slight difference between our height in the morning and at night. The explanation is to be found in understanding exactly how our backbone is made. The backbone consists of a number of bones, or vertebrae, and between each bone there is a disc made of cartilage. The object of this disc is to lessen the shock that would otherwise be felt on moving. Now, after being in an upright position for many hours, it is possible that the weight of the body squeezes these discs somewhat and makes them a little flatter, so that the total height is slightly reduced. During the night we must suppose that they resume their natural thickness by elasticity, and so stretch the backbone to its full length. In that way we may be a little taller in the morning.

WHY DOES EVERYONE GROW OLD?

No one knows why we grow old. We know that all plants and animals, including man, grow old and finally die, but we do not know the reason. Some trees and some animals live longer than others but we do not know the reason for this either. Every time we move, talk or walk we break down cells in our bodies. These are replaced by other cells, and the body tries to get rid of the dead material in one way or another. Some scientists think that our bodies do not get rid of all the waste matter, and that it slowly but surely poisons us.

Then, too, few people live very long without some serious illness. This may weaken an organ, so that it never again works as well as before. Old age is not measured entirely by years. Some people are older at fifty than others are at seventy. Our ancestors have something to do with growing old, and with length of life. Members of some families seem to grow old early while other families stay strong much longer, and generally live longer.

However, we can do something about the matter ourselves. People who do not eat too much or drink too much, and who get enough sleep usually stay young longer than those who do the opposite. We have told you elsewhere that the body gets rid of poisons during sleep. Great worry or sorrow has its effect upon the body also. Unhappy and fretful people are likely to seem older, and are really older, than those who are calm and cheerful.

THE NEXT WONDER QUESTIONS ARE ON PAGE 5957.

Sovfoto

View of the Kremlin at Moscow. The Kremlin is a walled enclosure in the center of the city; it contains famous palaces and churches and is now the seat of the Soviet government Special passes are needed to enter it.

THE SOVIET UNION

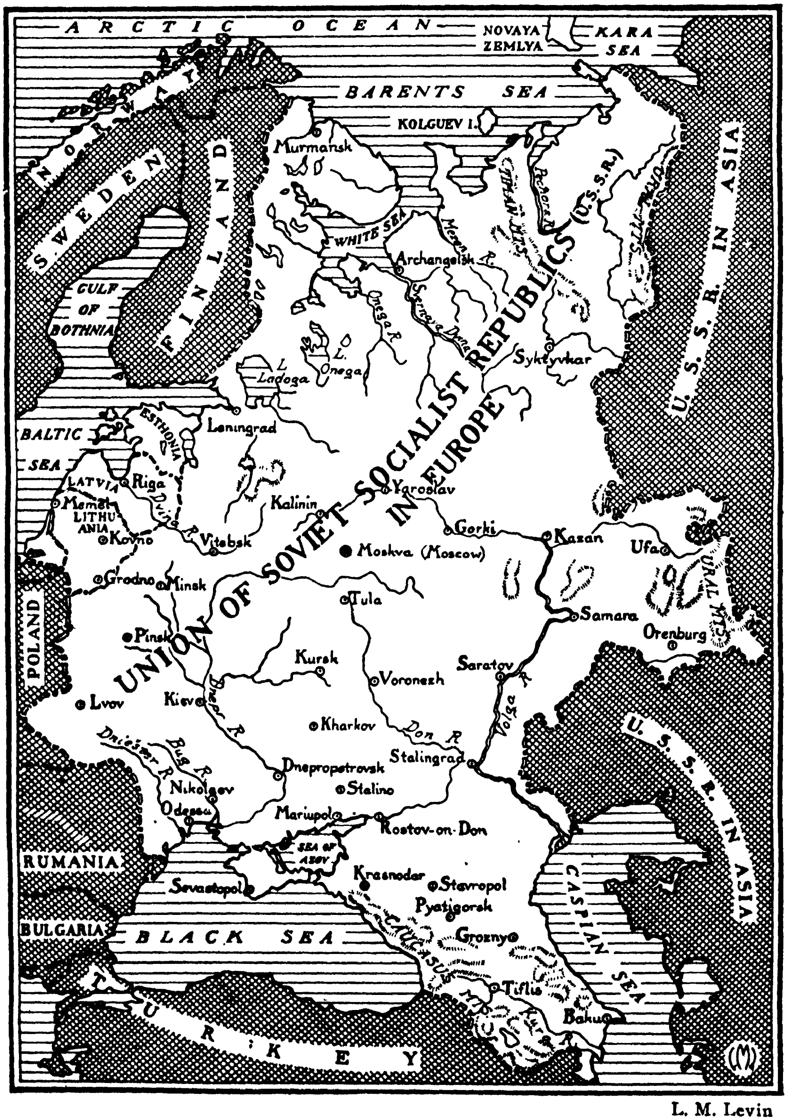
WE learned in the chapter on Russia and Her Story that Tsar Nicholas II was forced to abdicate in March, 1917, following a revolt of the Russian people. The Duma, or Parliament, took over the power, and a provisional (temporary) government was set up under Prince Lvov. Under this liberal statesman and under Alexander Kerensky, a socialist lawyer who followed Lvov in office, the provisional government set about the difficult task of curing Russia's many ills. It did not, however, please the peasants—and most of the Russians were peasants. Moreover, it tried to carry on the war, though the people were utterly war-weary. Support of the new liberal government waned quickly.

The soviets and the Bolshevists now began to be important factors. Let us explain what these two words mean. During the unsuccessful revolution of 1905 councils of citizens had been formed for the purpose of taking over power. Such councils are called soviets in the Russian language. These councils again became important in the successful revolution of 1917. Many soviets of workers, soldiers and peasants were formed, and they sent delegates to a great meeting in the capital city of Petrograd. (This city had originally been called St. Petersburg; the name was changed to Petrograd at the beginning of World War I. Today it is known as Leningrad.)

The men and women at this Soviet Congress were at first divided as to what was to be done. Some wanted to support the new liberal government; others wished to see stronger steps taken. Among these the leaders were a group called the Bolshevists, or Bolsheviks, which in Russian simply means "the majority," as they were the majority of their own political party. Led by Nikolai Lenin (see Index, under Lenin), the Bolshevists gradually swung the soviets to their views and they gained the support of the soldiers in the capital. On November 7, 1917, there was another revolution in Leningrad, and this time the Bolshevists seized the power. Their organization came to be known as the Communist party.

The Bolshevists believed in communism—that is, a state of society in which the government, land and machinery would be controlled by the workers; a state of society in which goods would be held in common. At first the Bolshevists were not strong in numbers, but they were able to put their ideas into practice because they had a definite plan and used strong measures to carry it out. They began by turning over the land to the peasants and by putting all business and industry in the hands of the state. Then, in March 1918, the new government made peace with Germany. This desertion was a terrible blow to the Allies. It left Germany free to exert all her strength on the western front, and she came very near to winning the war.

The Bolshevists met with great opposition in carrying out their program. The nobles and the owners of land and factories did not willingly give up their property. Remnants of the old army, under generals opposed to the new order, waged war against the government, aided by troops landed by the Allies. Newly risen states, such as Finland and Poland, also took the field against Russia. The Bolshevists were able to raise a huge Red Army—red is the color of revolution—and at times they were fighting on more than a dozen fronts. This period of civil war ended in 1922 with the defeat of the so-called White forces.

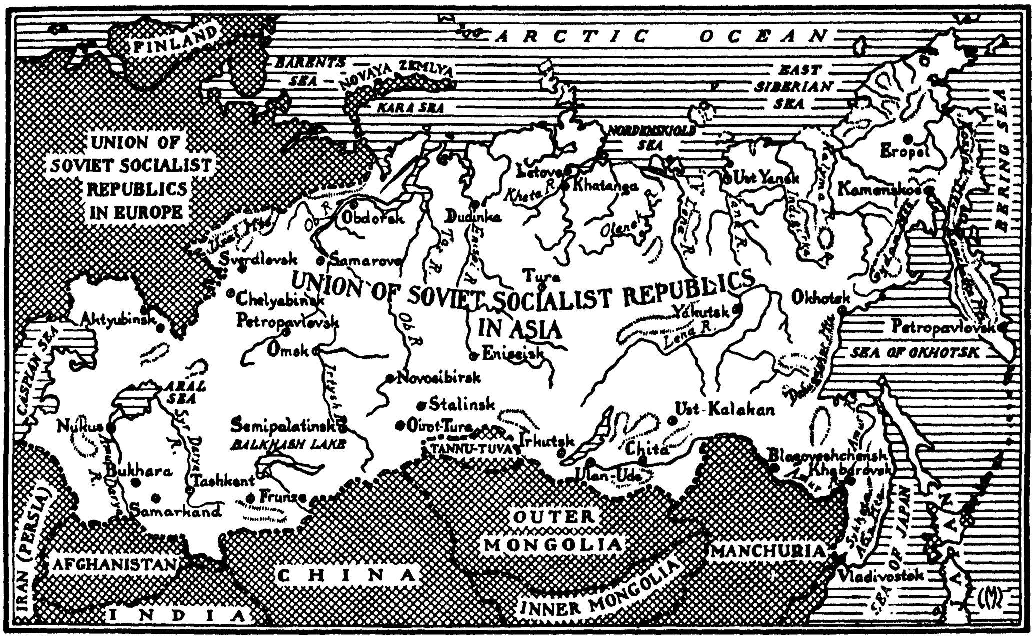


L. M. Levin

This map shows the European area of the Union of Soviet Socialist Republics.

The Bolshevists had won, but they found themselves in control of a country in ruins. In the west much of old Russia's richest territory, with 25,000,000 people, was lost to Rumania and the new states of Finland, Poland, Lithuania, Latvia and Estonia. Terror stalked through the land. Tsar Nicholas II and his family had been put to death, to be followed by thousands of others who were against the new order. Tens of thousands were forced into exile in Asiatic Russia or abroad. Industry and transport were nearly at a standstill. When the peasants found that they had to give much of their crops to the state, they refused to raise more than they needed for themselves. The result was that there was famine in the land and millions died.

To keep the country from utter disaster, the Bolshevists had given up a good deal of their radical program in 1921. In that year



L. M. Levin

The Soviet Union in Asia. Northern China, Mongolia and Manchuria are also under Soviet influence.

they set up a New Economic Policy, which remained in force until 1928. This policy provided that state industry and private industry were to exist side by side. It was an uneasy alliance, however; those who carried on business and farming in the old way were tolerated, but not encouraged.

During this period there was a serious political crisis. The nation's leader, Nikolai Lenin, died in January, 1924. There followed a fierce struggle for mastery between two of Lenin's followers, Joseph Stalin and Leon Trotsky. (We tell you about these men in the article called Recent European Statesmen.) Stalin won out, and as secretary-general of the Communist party he became the dictator of the country. Trotsky continued to lead the opposition to Stalin; in 1928 he was exiled. In 1940 he was assassinated.

In the meantime the rulers of Russia had worked out a great five-year plan for the remaking of the country. It was aimed to bring about a great development of industry; it provided in detail just what should be built and how much should be produced in every field. It also covered transportation, agriculture, education—in short, every form of human activity. In 1928 the New Economic Policy came to an end, and the five-year plan began.

The plan was declared completed after less than five years. In some fields it fulfilled and even exceeded its goal; in others it fell short of the mark. Russia had always been backward industrially. During the period of this five-year plan great factories and power plants were built, mainly under the direction of foreign engineers. Mass production of tractors and motors cars was started. Education made great strides. Agriculture was reorganized. Many of the small farms of the peasants gave place to big collective farms, where farm machinery was used on a large scale. But agricultural production did not catch up to the demand, and there still remained a serious shortage of food. The development of the railroads lagged somewhat behind. So did the supplying of everyday needs.

A second five-year plan was begun on January 1, 1933. This brought about a large increase in industrial output, electric power development and grain production. The total output would not seem large to Americans or Canadians, but it was much bigger than the Russians had ever before achieved. The Russian people as a whole were still badly housed, poorly clothed and had few modern comforts.

While the second five-year plan was still under way, war clouds began to gather over Europe. Russia tried at first to oppose the rise of nazi Germany. But she could not

Sovfoto

Sheep grazing on a pasture at the foot of Mount Kazbek. Mount Kazbek is a lofty peak of the Caucasus range, which lies between the Black and Caspian seas.

come to terms with the democracies of Great Britain and France, who were also alarmed by the aggressive policy of Germany's leaders. Suddenly the world was startled to hear that Russia had signed a treaty with Germany (August 24, 1939). Each of these states agreed not to fight the other if war broke out in Europe. A few days later (September 1, 1939) the Germans invaded Poland and World War II was on.

Poland, the first victim of the war, was divided up between Germany and Russia on September 29, 1939. Two months later the Russians went to war with Finland, which had refused to give up certain territories along the Russo-Finnish frontier. In March, 1940, the Finns gave up the fight, and Russia won considerable Finnish territory. In 1940, too, the Russians annexed the formerly independent republics of Estonia, Latvia and Lithuania, and the Russians also made Rumania give up Bessarabia and northern Bukovina.

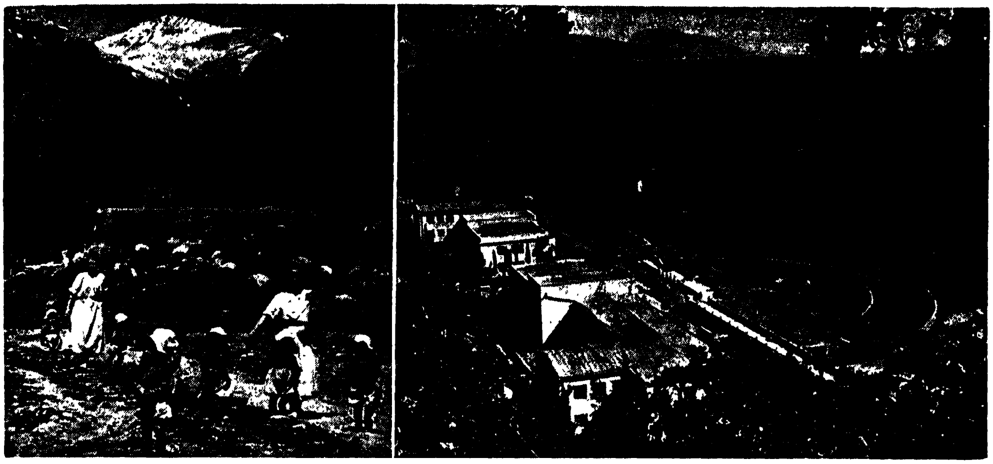
For almost two years after the signing of the treaty of 1939, Russia and Germany got along fairly well together. But in June, 1941, Germany launched a sudden attack on Russia, and there began a terrible struggle along a fighting line that in time stretched from the Arctic Circle to the Black Sea. Aided by some of their Axis allies and by Finland, the Germans had everything all their own way at first; they conquered a large part of European Russia. But the Russians fought back stubbornly.

We tell you about the fighting between the Russians and Germany and her allies in our article on the Two World Wars. Twice the Germans penetrated deeply into Russian territory and seemed about to strike a deathblow: twice they were hurled back by desperate Russian counter-attacks. As soon as possible after the German attack upon Russia; Britain, Canada and the United States began shipping every kind of aid to the Russian government. This included planes, tractors, trucks, guns, munitions and military equipment of all kinds, besides foodstuffs and medical supplies.

Thus by her own efforts, and with Allied aid, Russia was victorious. In the struggle millions lost their lives, cities were frightfully battered, industry was wrecked, poverty stalked the land. In August 1945, the Soviet Government announced another five-year plan, to end in 1951. The plan included rebuilding the wrecked areas and putting industry back on its feet. Great factory centers are being developed in the Ural Mountains and in northern Asia.

Soon after the war's end, Russia began to extend her power. In Europe, Bulgaria, Rumania, Yugoslavia, Hungary, Czechoslovakia and Poland became Russian "satellites." (A real satellite is a moon tied to a planet by force of gravity. The chief force that ties these countries to Russia is trade.) They have become totalitarian states, with the Communist party in full control. Yugoslavia later lost Russia's friendship. In Asia, Communists won control of much of China, Mongolia and Manchuria. The satellite states have been called "countries behind the Iron Curtain," because it is difficult for democratic nations to find out what is happening in them. It is as though an iron curtain had been let down between them and us.

Russia is an immense country. Its area is about 9,000,000 square miles; it sprawls across two continents with no real break except the Ural Mountains which form the

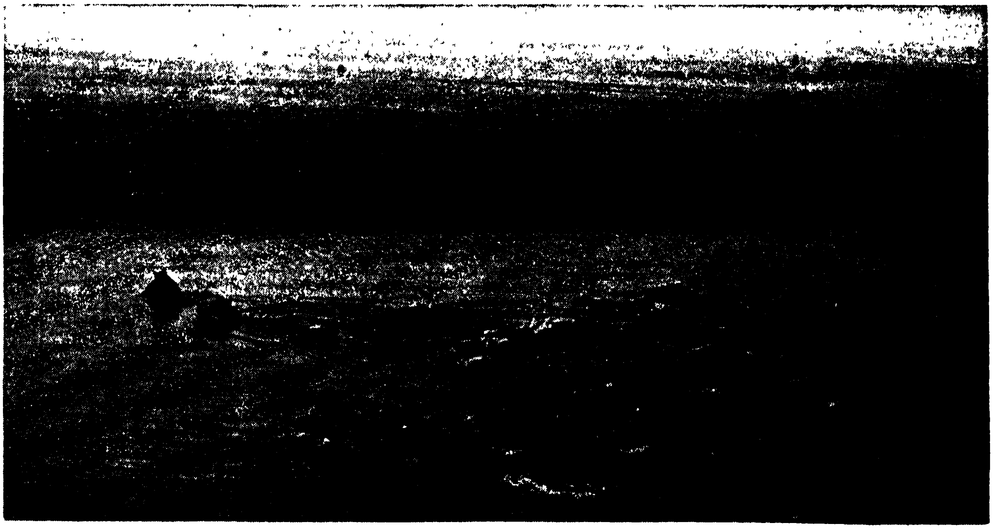


Left: out for a walk on the Kirov collective farm. Right: the Kurpati sanatorium in the Crimean Peninsula.

boundary between Europe and Asia. This is very nearly one-sixth part of the land surface of the earth.

In the extreme north of Russia, much of which is within the Arctic Circle, lies the region of the tundras, boggy ground frozen nearly all the year, supporting only wandering tribes that keep reindeer. To the south of this region lies the great forest belt which contains the world's largest continuous forest. From the air it seems a vast sea of leaves. Here is a nearly inexhaustible supply of birch and pine, elm and oak. Fur-bearing animals make the forests a profitable hunting-ground for the trapper and quantities of valuable skins are produced—bear, fox, marten and sable.

South of the Urals and extending into central Asia lie the vast steppes, treeless plains much like the grassy ranges of our continent's old West. This is the great animal-raising region, where millions of cattle, horses and sheep graze. In the southern part of European Russia are great areas of what is called "black earth," a rich soil largely composed of the remains of vegetable matter.



All photos, Sovfoto

A drove of horses bathing, in the steppe country. Horse-breeding is widespread in this area of the Soviet Union.

"Swan Lake" ballet, from a noted Russian motion picture.

This black earth is so fertile that all sorts of crops grow very luxuriantly. The Ukraine, immediately north of the Black Sea, is in this region.

The great Russian plain offers no barrier to the winds which sweep across Asia and those from the northern ocean. There are few mountains to make the clouds give out their moisture. Thus Russia is a land of extremes of temperature. The winters grow more severe as you go eastward. In general the snow during the long cold winter lies thick on the ground, right down to the shores of the Caspian Sea. The winter had much to do with defeating Napoleon in 1812 and Adolf Hitler in 1941 and in 1942.

In the north the days are very long in summer and short in winter. Even in Leningrad there are "white nights" in summer, when it hardly grows dark at all. As far south as Moscow the summer nights are very light, and after ten in the evening the gilded church domes still shine brightly in the after-glow.

Spring comes with a sudden splendor in Russia. By June it is so hot over the central and southern regions that it seems unbelievable there ever could have been snow.

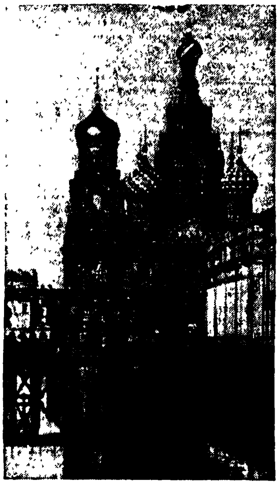
The Ural Mountains, which divide European Russia from Russia in Asia, rise gently from the plain, a series of ranges with rounded summits, forming no serious barrier to road and rail. They are rich in copper, platinum, iron and coal. They do not run all the way down to the Caspian Sea, but leave a large gap where the river Ural runs through the steppes. Between the Black and Caspian seas run the rugged Caucasus Mountains. This is a region of varied scenery, where one may see glaciers and also subtropical vegetation. To the south there are other great ranges stretching into Turkey and Iran (Persia).

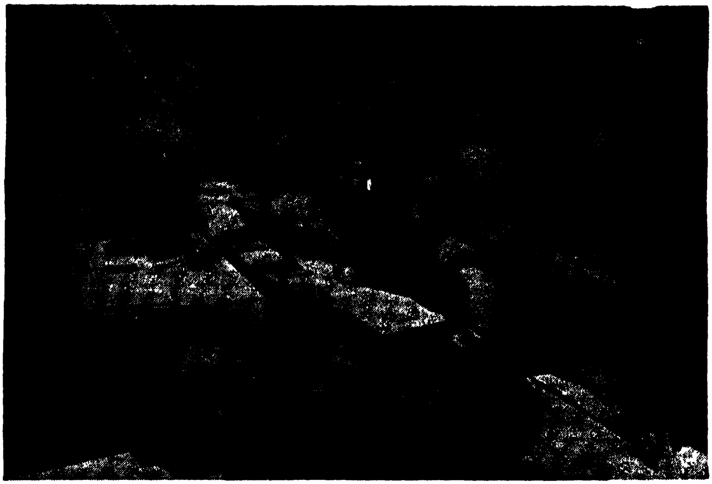
As most of the slopes are very gradual, Russian rivers flow gently and are well suited for water traffic. The evenness of the land also makes it easy to build canals. Many of these connect the various river systems. This waterway system is very important for Russia. From Leningrad, the port on the Baltic, goods may be taken right across Russia, almost to Iran without unloading. One of the important waterways is a canal connecting the White Sea with the Baltic.

Russia is not particularly well off in regard to sea traffic. The great Volga empties into the inland Caspian Sea. The way from the Black Sea ports to the Mediterranean, by which Russian grain is shipped, is

Both photos, Sovfoto

A track meet in modern Russia. Under the soviets every encouragement has been given to outdoor sports among the people. The result has been extremely gratifying.



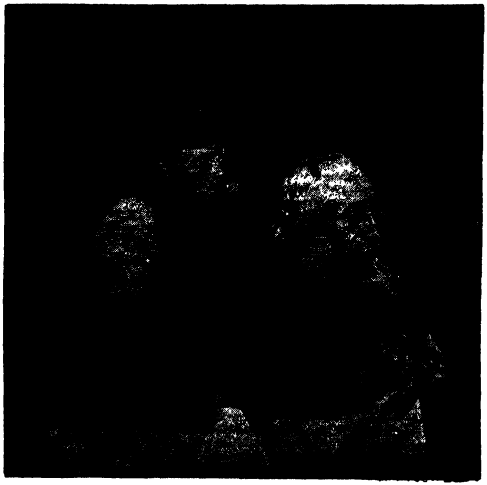


Upper photos, Sovfoto

Left: the Griboyedov Canal, in Leningrad. Right: a geography lesson in the sixth grade of a Moscow school.

guarded by the Turks and may easily be blocked in times of war. That is why Russia casts longing eyes at Istanbul (Constantinople). In Asiatic Russia the Ob, Yenisei and Lena rivers flow into the Arctic Sea, and the Amur into the North Pacific. These channels are ice-bound much of the year.

Many different stocks are represented in Russia's population, which numbers about 193,000,000. The largest group is that of the Slavs. They include the Great Russians of the center, Little Russians or Ukrainians, White Russians or Bielorussians and Poles.



Ewing Galloway, N. Y.

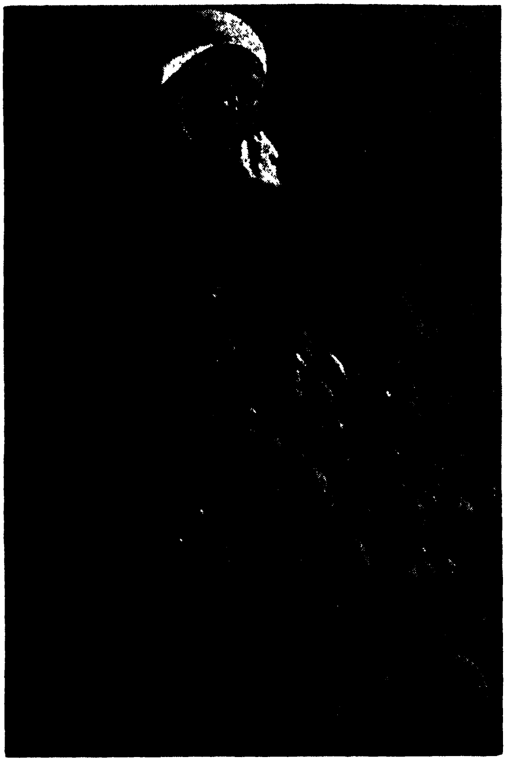
A group of farm workers listen attentively to a lecture which is being given by a Soviet farm agent.

Then there are many branches of the Finno-Tartar family, from the Karelians of the Finnish border to the Samoyeds of the frozen north and the Chuvashes of the banks of the Volga. They have rather flat faces, high cheek bones and pronounced jaws. The Tartars themselves are dark and short people, Asiatic in type.

Tartar blood, however, is so widespread in Russia that there is saying, "Scratch a Russian and find a Tartar." The nomadic, cattle-raising Khirgiz, roaming the steppes, are also of Tartar stock. Another nomad tribe extending deep into Asia are the Kalmucks, a pure Mongol type with slanting eyes like the Chinese. In the far northeast dwell primitive tribes such as the Chukchi, who resemble the Eskimos and Indians of the north, lending color to the belief that America was peopled from Asia. The famous Cossacks of the steppes east of the river Don are of mixed blood—Slav, Tartar and Mongol.

Some peoples of the Caucasus have been considered typical of the whole white race, which is therefore often called the Caucasian. The Circassians, for example, are a tall, handsome people of noble bearing. There are also many Jews in Russia, especially in the towns of White Russia and the Ukraine. A large territory in Asiatic Russia has been set aside for settlement by Jews. It is called Biro-Bidjan.

The chief language of the country is Russian, one of the world's most important tongues. Many other languages and dialects



Sovfoto

Russia grows fine potatoes on her collective farms.

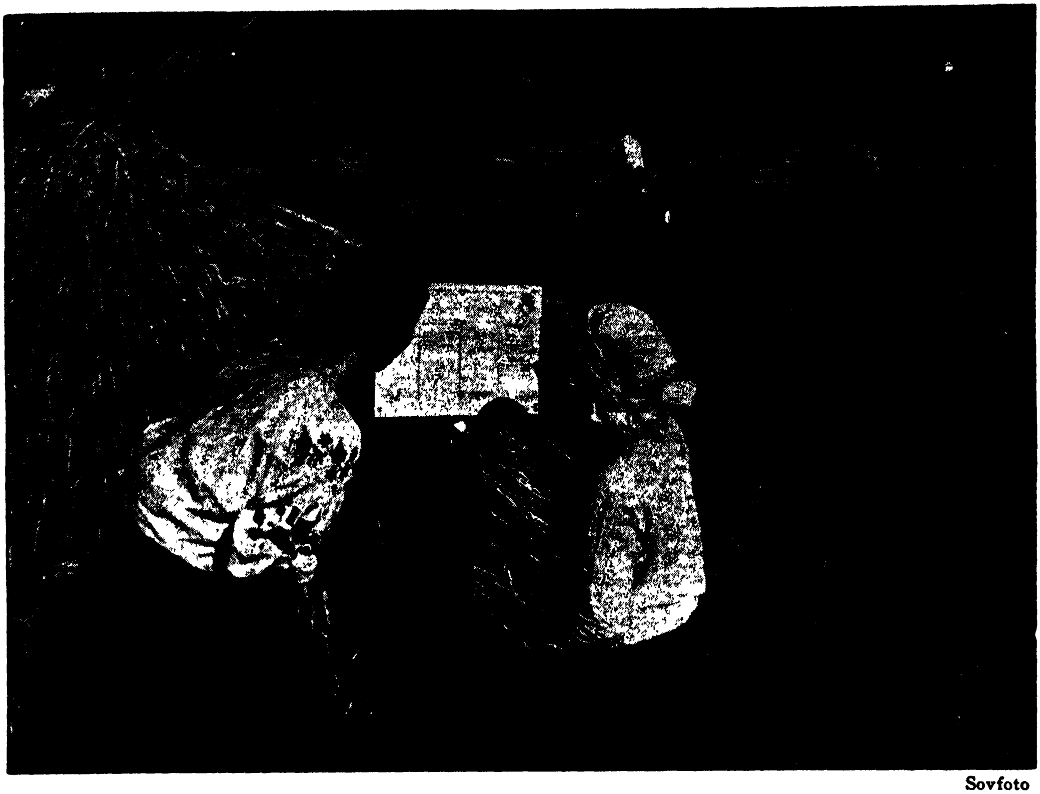
—about 150 in all—are spoken. Many religions, too, are represented. Foremost among these is the Russian Orthodox Church. Communism generally is opposed to religion, but the Soviet Union allows its people to practice their faith under stern government control. Within Russia this control is absolute. In some of the satellite states the churches have suffered in the struggle to keep their freedom.

Education is far more widespread nowadays in Russia than in the days of the Tsar. All children must go to school when they have reached their seventh year. Since January, 1934, there have been three types of schools—those with four-year, seven-year and ten-year courses. Higher education has also made great progress. There are more than 700 universities and colleges of all kinds in Russia. The most noted universities are those of Moscow, Leningrad, Kharkov, Odessa, Dorpat, Kazan and Kiev.

Russia's many peoples, with their different traditions and languages, live peaceably side by side under a government which does not tolerate racial prejudices. The country is ruled under a constitution that went into effect on December 5, 1936. In this constitution the official name of Russia is given as the Union of Soviet Socialist Republics (U. S. S. R.). The Soviet Union, as it is often called, is made up of a number of separate states, something like the United States, though the central government of Russia has a great deal more power. Some of the Russian states are themselves unions of smaller states. The states that form the Soviet Union are:

1. The Russian Socialist Federated Soviet Republic (R. S. F. S. R.). It contains most of Russia's total territory and a majority of the population.
2. The Ukrainian Soviet Socialist Republic, the most densely populated of the Russian republics. Carpatho-Ukraine (Ruthenia), which was ceded to Russia by Czechoslovakia in 1945, is now a part of the Ukrainian Soviet Socialist Republic.
3. The White Russian, or Bielorussian, Soviet Socialist Republic.
4. The Azerbaijan Soviet Socialist Republic.
5. The Georgian Soviet Socialist Republic.
6. The Armenian Soviet Socialist Republic.
7. The Kazakh Soviet Socialist Republic.
8. The Khirgiz Soviet Socialist Republic.
9. The Turkmen Soviet Socialist Republic, also called Turkmenistan.
10. The Uzbek Soviet Socialist Republic, also called Uzbekistan.
11. The Tajik Soviet Socialist Republic, also called Tajikistan.
12. The Karelo-Finnish Soviet Socialist Republic. It is made up of the former Karelian Autonomous (self-governing) Soviet Socialist Republic and the territory taken from Finland in 1940.
13. The Moldavian Soviet Socialist Republic. It is made up of the former Moldavian Autonomous Republic and Bessarabia, which was taken from Rumania in 1940.
14. The Estonian Soviet Socialist Republic—formerly the independent country of Estonia.
15. The Latvian Soviet Socialist Republic—formerly the independent country of Latvia.
16. The Lithuanian Soviet Socialist Republic—formerly the independent country of Lithuania.

Under the constitution adopted in 1936, the central government power rests in a Supreme Council (Soviet). It consists of two chambers, the Council of the Union,



Sovfoto

Women harvesters in the Ukraine reading a field newspaper. The Ukraine is one of the most fertile areas in the world, and has been called Russia's "bread basket." All kinds of crops flourish in this region.

elected by the people, and the Council of Nationalities, selected by the governments of the several republics and areas. There is only one political party in the Soviet Union; that is the Communist party.

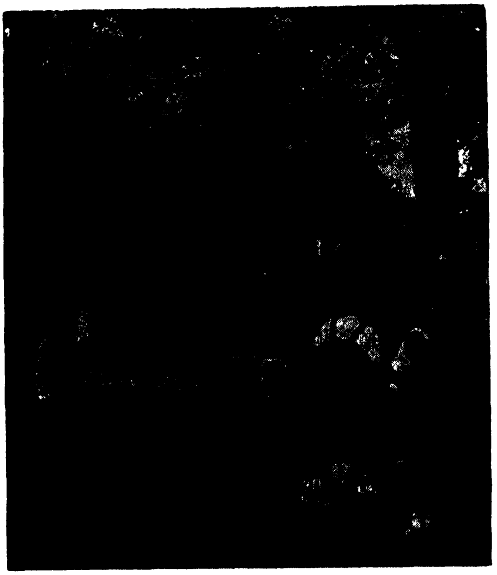
Russia has an immense area suitable for agriculture—an area estimated at more than a billion acres. About one-eighth of this land is cultivated at the present time. Wheat is the chief crop; rye, millet, oats, sugar-beets, potatoes and many other crops are also raised on a large scale. Ordinarily Russia is well able to feed herself and also to export foodstuffs. With the use of large-scale scientific farming, the yield of crops has greatly increased. Russia's timber lands cover over 3,000,000 square miles, and they are an important source of national wealth. We have spoken of that other important source of forest wealth, furs.

Russia is rich in minerals. In the basin of the Donets River and in other parts of the Ukraine there are vast deposits of coal and iron. Russia also has big deposits of platinum, gold, manganese, copper, zinc, lead, nickel and other minerals. A good deal of this mineral wealth has not yet been developed.

The organization of industry in the Soviet Union is based on state ownership and control. Industries are organized in trusts, of which there are over 600. There is the Rubber Trust, the Silk Trust, the Urals Asbestos Trust and so on. In some industries there are several trusts. The oil and cement industries, for example, have four each.

We have already told you about the great advances that the first two five-year plans brought about in the industrialization of Russia. Many new enterprises were also launched in the dark days of World War II. These include a huge blast furnace at Magnitogorsk and a big iron and steel works—the largest in Europe—at Chelyabinsk.

Russia's output of electricity has kept pace with her industrial growth. Few countries have made such effective use of water power in generating electricity. In the days before the war a great hydroelectric power



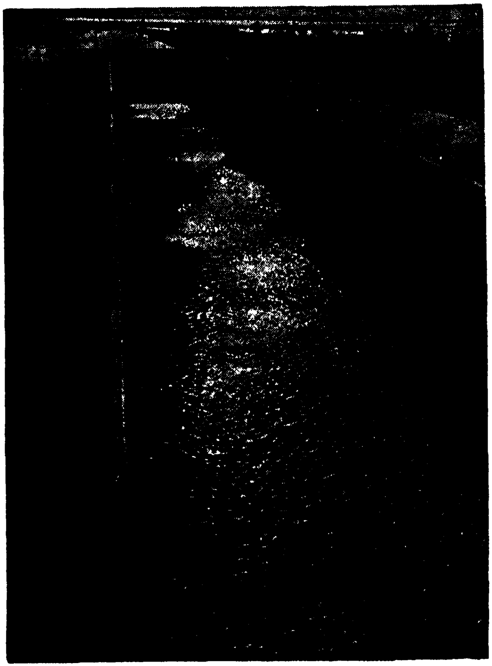
An "auto-store" in a big city park of Dnepropetrovsk, a flourishing city on the Dnepr (Dnieper) River.

development was built on the lower Dnieper River, under the guidance of American engineers. This development, known as the Lenin Hydroelectric Station, was the largest in all Europe. In 1941 the Russians dynamited the Lenin Station when the Germans approached. The nazi forces were driven out of the area at last, and the Russians began to rebuild the station even before the end of the war.

We have mentioned the part that rivers and canals play in Russia's transportation. Her railroads are becoming increasingly important. Even before World War I Russia had the longest continuous railroad in the world—the Trans-Siberian Railroad, extending from Leningrad to Vladivostock, a distance of 5,435 miles. Under the Soviet Union the Russians have added considerably to the mileage of their railroads. Automobiles, busses and trucks have also become important in the transportation system, and good roads for them have been built. In the last days of the Tsar, Russia had only 3,000 miles of paved roads; today there are over 300,000 miles of main highways. The Russians have also made great progress in air transport; the air-freight system is very extensive.

The capital and chief city of Russia is Moscow (population 4,137,000). It is a great industrial center and at the same time a city of great charm. Above the buildings and streets of the modern town rise the domes of the old churches. Some glitter with gold, others are painted bright blue or sea-green. The famous Kremlin, once the citadel, dominates the city. It is a great walled inclosure, with walls of old red brick, beautiful gates and towers roofed with brilliant green tiles. Inside are magnificent churches and palaces as well as government buildings. The Kremlin is the headquarters of the Soviet Government and special passes are needed to enter it. Moscow has a beautiful subway, built a few years before the outbreak of World War II. The stations of the subway are finished in marble.

Leningrad, the former capital, was originally built by Peter the Great to give Russia "a window looking out to the west." Despite its poor situation—it was built on a swamp—it grew into one of the great cities of Europe, with splendid palaces and monuments. During the great change that came over Russia following the revolution of 1917, Leningrad fell upon evil days, but now it is flourishing again. It is a great seaport on the Baltic and, like Moscow, is an important industrial center. More than one-tenth of Russia's industry is concentrated here. At the same time it is a center of culture, with many museums and scientific institutions.



Both photos, Sovfoto

The Stalin White Sea-Baltic Canal, opened in 1933.

It has a population of more than 3,191,000.

Kiev (population 846,000) is the capital of the rich Ukraine. Once the holy city of Russia and the ancient seat of the Russian princes, it is one of the most picturesque cities of Europe. Before World War II it was famed for its magnificent churches and monasteries, many of which had been transformed into museums and schools. Many of the city's historic relics were destroyed in the fighting that took place in and near the city in the war.

Kharkov (population, 833,000) has giant factories making locomotives, tractors and electrical machinery. Odessa (population, 604,000) is one of the chief ports on the Black Sea and a great health resort. With its great flight of steps leading down to the harbor and with a population made up of many different stocks, it is unlike any other city in Russia.

The city of Sevastopol (population, 112,000), which saw much terrible fighting in World War II, is one of Russia's foremost seaports. It is situated in the Crimea, a peninsula which extends out into the Black Sea and which is famous for its health resorts. Yalta, one of these resorts, was the scene of a historic meeting in February, 1945, between Premier Stalin of Russia, President Roosevelt of the United States and Prime Minister Churchill of Great Britain.

Baku, the great oil center on the Caspian Sea, is dominated by the ancient citadel of the Tartar khans. Thence a great pipe line carries the oil to the Black Sea port of Batum, famous as a health resort, with an almost tropical climate. Tiflis, picturesquely nestling in a mountain valley in central Transcaucasia, is one of the oldest cities in the world.

Tractors are manufactured at Stalingrad, on the Volga River. In the southern Ural Mountains, near large deposits of iron ore, is Magnitogorsk. Bukhara and Samarkand are ancient cities in central Asia.

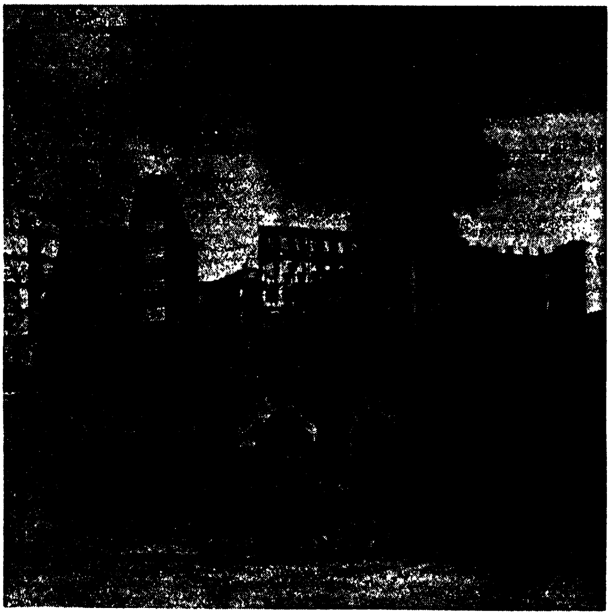
Although Soviet officials frequently speak of Russia as a democracy—in fact, they claim it is the only true democracy—it is very far from what we in the west consider democratic. The government controls and directs every department of life. It decides where each Russian is to live and work, what he is to be taught, what kind of books he may read, what sort of music, drama, and painting he may enjoy. Anyone who objects to this state of affairs is considered an enemy of the people. Enemies of the people usually end their lives doing forced labor in concentration camps.

Sovfoto

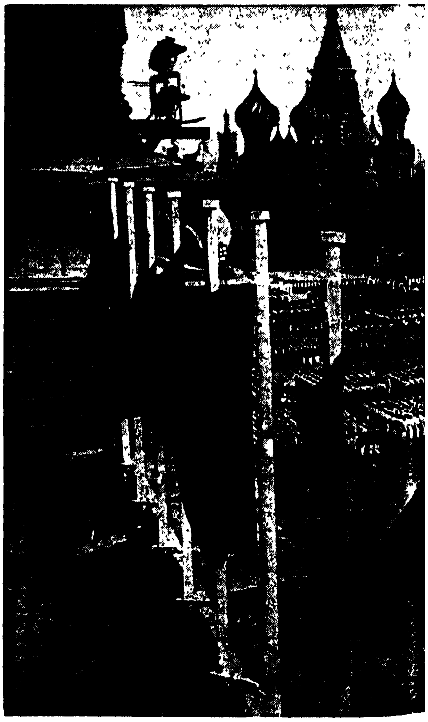
The Stalin metal works in Kuznetsk. This is one of the Soviet Union's largest industrial plants in Asia. World War II saw a tremendous development of industry in the vast Russian areas beyond the Ural Mountains.

All photos on pages 5858-59, Sovfoto

A river steamer touches at a pier at Kuibychev, an important port on the Volga River. This beautiful and romantic waterway has for centuries been a great highway of commerce serving the cities of Russia.

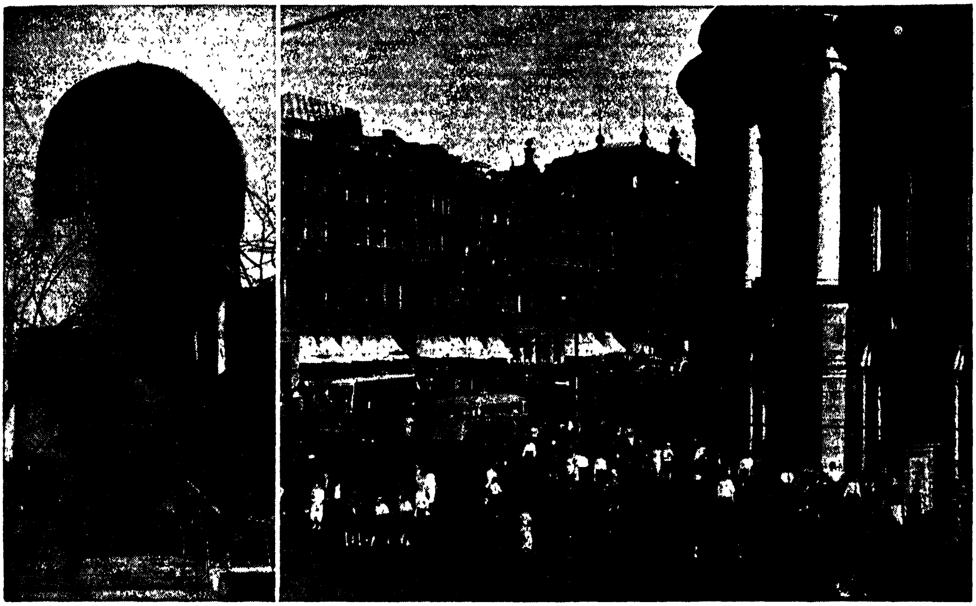


Ruins of Stalingrad, on the Volga River, after the German besiegers had been driven back. In August, 1942, the city became the object of a desperate struggle between the German and Russian forces. The struggle lasted for months; the fight went on in the city streets, from house to house and even from room to room. The Russian defenders held firm. Later the German besiegers were trapped by another Russian army and they were forced to surrender at last in February, 1943.

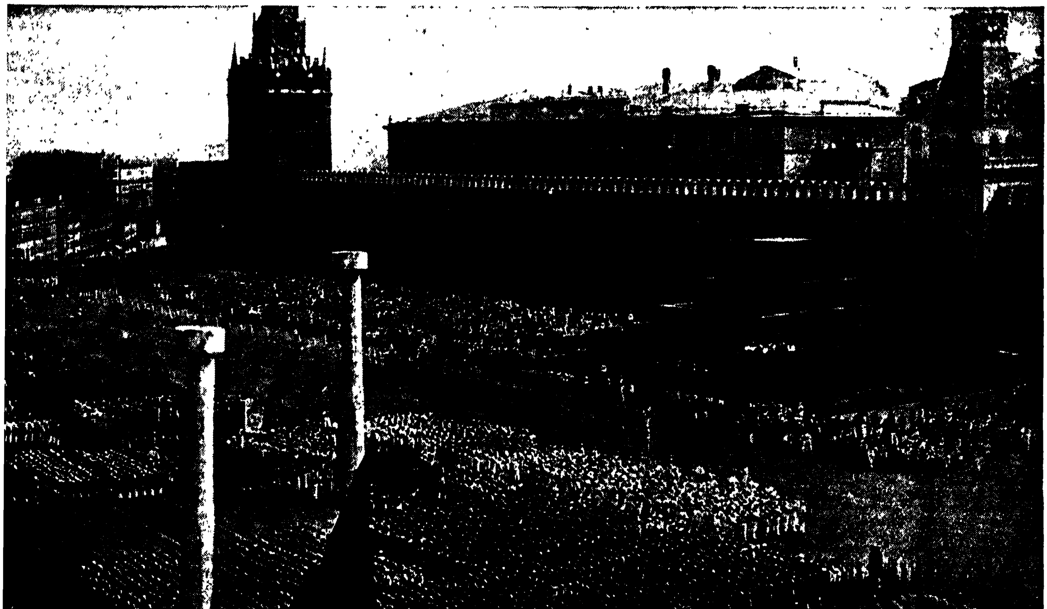


Moscow's Red Square during a sports parade.

IN CITIES OF THE SOVIET UNION



Left: Tomb of Tamerlane at Samarkand, in Uzbekistan. Right: a busy street corner in the city of Leningrad. Originally called St. Petersburg, or Petrograd, Leningrad was built by Tsar Peter the Great as his capital.



In the background, to the right, is the mausole or tomb, where the body of Lenin lies in a crystal casket.

ESTONIA

ESTONIA, with an area of about 18,000 square miles, extends along the south of the Gulf of Finland, from the river Narva and Lake Peipus westward to the Baltic Sea. Its population of over a million is composed almost entirely of Letts, akin to the Finns in both descent and language. Most of the people are Lutherans.

Estonia has passed through many changes of government in the course of its eventful history. From 1710 to 1918 it was a part of the Russian Empire. In 1918, it became an independent republic and remained a sovereign state until 1940. In that year it was occupied by Russian troops and became a member of the Union of Soviet Socialist Republics. When Germany invaded Russia in the summer of 1941, nazi troops occupied all of Estonia. The Russians later reconquered the land, and it is again a soviet socialist republic.

The country has much fertile farming and pasture land. About one-fifth of Estonia is forest; there is also an immense peat bog covering many thousands of acres. Agriculture is the main occupation of the inhabitants; the chief crops of the country include rye, barley, oats, potatoes and flax. The most important port is the capital, Tallinn, or Revel (population, 445,000), on the Gulf of Finland. Pernau is the next most important port. Narva, situated at the mouth of the river Narva, is a manufacturing center, with many cotton and woolen mills.

LATVIA

LATVIA lies on the Baltic Sea, south of Estonia. It has an area of 25,000 square miles and a population of about two millions, most of whom are Protestants. Latvia is the home of the Letts, who are a people akin to the Lithuanians. Like Estonia, Latvia was under Russian rule for several hundred years; it won its independence in 1918.

From that time, its history runs parallel with that of its sister Baltic states, Estonia and Lithuania. It lost its independence in 1940, when Russian troops took over the country. For less than a year Latvia was a member of the Soviet Union. Then, after war broke out between Germany and Russia in June, 1941, it was occupied by the Germans. Later it was recaptured by Russia and once more entered the Union of Soviet Socialist Republics.

Latvia is a flat land of forests, lakes and rivers, grouped about the lower course of the river Dvina. Its ports have excellent harbors. Its work is much the same as that of Estonia: the growing of rye, oats, barley, flax and potatoes, dairying and the use of the timber in its large forests.

The seaport of Riga, Latvia's capital (population, 393,000), is the chief outlet for a great inland trade from as far as Russia's Asiatic territories. Riga, which was founded in 1201, is today the largest port of the Baltic. Its sturdy ice-breakers keep the harbor free during the winter months. Libava (Libau, or Liepaja), with a population of 57,000, is the second port of Latvia.

LITHUANIA

LITHUANIA is the southernmost of the three Baltic states. Unlike its two neighbors, it was one of the great states of Europe in former times; in the fourteenth century its territories extended from the Baltic to the Black Sea. By the marriage of the Lithuanian grand duke, Jagiello, with the queen of Poland in 1386, the two countries became united. At the end of the eighteenth century, Lithuania fell under Russian rule.

The country won its independence in the year 1918. In 1940 Lithuania was seized by Russian troops and it became a full-fledged member of the Soviet Union. In the following year it was occupied by the Germans. The Russians recaptured the country and it is now again a member of the Union of Soviet Socialist Republics.

Lithuania has an area of about 23,000 square miles. Of the population of about 3,000,000, by far the greater part are Roman Catholics. Agriculture is the principal occupation of the inhabitants. The chief crops of the country are rye, wheat, barley, oats, potatoes and flax.

The capital of Lithuania is Vilna (Vilnius, or Wilno) which has a population of 208,000. The only other large city is Kovno (Kaunas), with a population of 152,000.

IN LITHUANIA, ESTONIA AND LATVIA

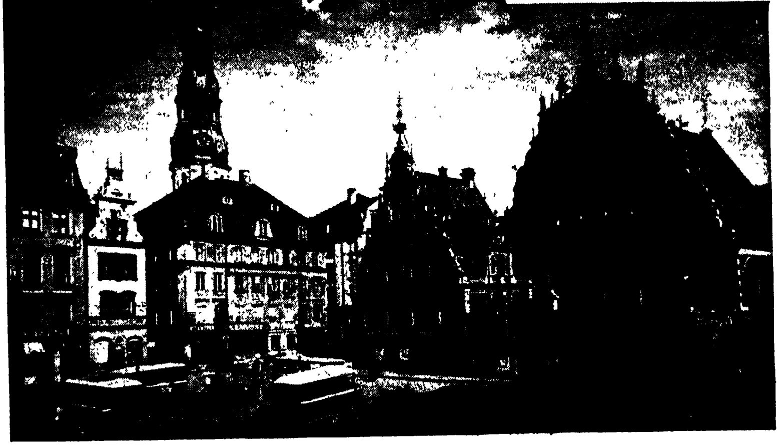
Top, bottom and left center pictures, Richards Collection

Left: a peasant couple on a big Lithuanian farm pitching hay. Right: a typical farmhouse in Lithuania.

Young ladies in the Lithuanian national costume.

© Ewing Galloway, N. Y.

The City Hall of Tallin, or Reval, in Estonia.



Town Hall Square, in Riga, Latvia. In the background is the spire of St. Peter's Church, the highest wooden structure in Europe.

FINLAND

ONE of the most beautiful countries in Europe is the "Land of a Thousand Lakes" (though there are really about 40,000). The outside world calls the country Finland, but the inhabitants call it Suomi (Swamp-land). Most of the lakes are in the southern half of the country and many are connected with the sea by canals. There is much marshy land but on the higher ground are great forests which furnish lumber and wood pulp. The amount of good agricultural land is small, and the climate is very severe in some parts of the country. In the far north the day in winter is only three or four hours long.

Courtesy, Finnish Travel Information Bureau

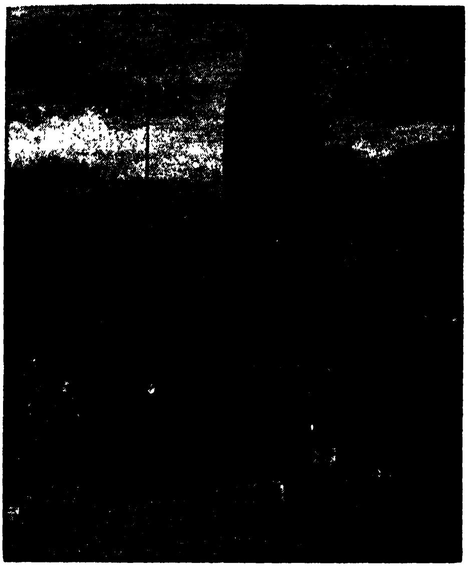
The southern harbor of Helsinki, the capital of Finland. Helsinki, formerly known as Helsingfors, lies on a small peninsula in the Gulf of Finland about 200 miles to the west of the Russian city of Leningrad. It has large manufacturies of linen, sailcloth, beer and carpets, and carries on an important trade in agricultural and dairy products. The University of Helsinki is one of the most renowned in Europe. Helsinki was founded in 1550 by Gustavus I of Sweden further inland, and was removed to its present site in 1640.

The Finns came from Asia, probably before the year 800 A.D. At first they seem to have had no settled government but lived in small villages. They cultivated a little land but depended more upon flocks and herds, and upon hunting and fishing. Some followed the sea, and, like the Norsemen, were sea-rovers and pirates.

Sweden tired of the attacks on her shores, and, in the year 1157, conquered part of the country and introduced Christianity. Later Russia conquered the rest of the country. The Swedes gave the Finns full rights of citizenship, built churches and schools and introduced printing. The Finns learned rapidly and many students attended the universities of Europe. Later Finland was made a grand duchy with a legislature of its own.

Though the Swedish language became common, the people never gave up their own. Many poems and songs were composed, and passed from one generation to another by word of mouth. Some of them were later published. The most famous Finnish work is a collection of these poems called the KALEVALA, printed in 1835. Longfellow imitated the style of the KALEVALA in HIAWATHA.

There were frequent wars between Sweden and Russia, and in 1809 the Swedes were forced to cede to Russia the Finnish area that they occupied. Finland, however, did not become a conquered province, but re-



Helsinki has a large and modern railway station.

tained a certain amount of political freedom. It became a Russian grand duchy, with the tsar as the grand duke.

Many Russian officials were jealous of the freedom of the Finns and wished to make them adopt the Russian language, church and government. In 1899, the liberties of Finland were suspended, and in 1903 a Russian governor was given despotic powers. The people would not endure this, and in 1905 the whole country went on a "national strike." The Russian Government was alarmed, and the former rights were restored, but only for a time. Soon the Russians again persecuted the Finns, and this state of affairs continued up to the revolution of 1917.

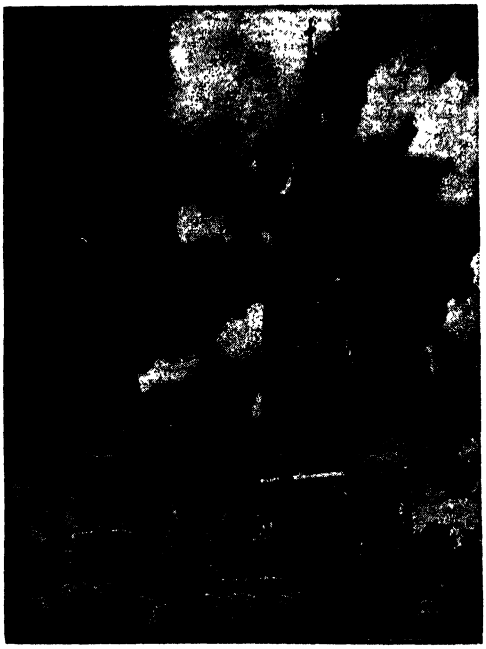
In 1917 the Finns declared their independence. Russian troops invaded the country, and a White Army was formed to oppose them. Finally with German aid the Russians were defeated. In 1919 a republic was established, and the Finns settled down to develop their country.

In the twenty years from 1919 to 1939 the Finns prospered. However, Russia had never been satisfied with the borders laid down after World War I. She feared that some day a hostile power, established along the Finno-Russian border, would shell Leningrad with long-range guns. In 1939, therefore, she asked for some Finnish territory, to serve as a protection for Leningrad in case of need. Naval bases were also demanded. Finland refused and on November 30, 1939, Russian armies invaded the little country.

The Scandinavian countries were sympathetic to Finland in her plight, but were afraid to aid her and refused passage over their lands when other countries wished to send help. The Finns fought heroically for 105 days; but the struggle was a hopeless one. In March, 1940, the Finns were forced to make peace, and they ceded to Russia 16,173 square miles of territory.

In 1941 Finland joined Germany in attacking Russia, hoping to regain her lost territory. She did recover it for a time. But then Germany and her partners began to lose ground everywhere. Finally, in September, 1944, Finland had to give up the fight. The Finns agreed to restore the frontiers that had been decided upon in the Soviet-Finnish peace treaty of 1940. They also agreed to pay the Russians $300,000,000 in reparations.

Finland is a republic, with a president chosen for a term of six years by an electoral college of 300, named by direct vote of the people. There is a single legislative chamber, the Eduskuntula. The Evangelical Lutheran Church is the state religion; however, all other sects have complete religious freedom. The present area of the country is about



Courtesy, Finnish Newspaper

The beautiful cathedral in the city of Tampere.

Burton Holmes—Ewing Galloway, N. Y.

The Imatra Rapids, in the province of Viborg in eastern Finland. A large power station was built by the government on the east bank of the rapids in 1921-29.

118,000 square miles; the population is estimated at 4,000,000. Helsinki, the capital, is the largest city, with a population of 305,000. Other important cities are Tampere (population, 77,000) and Turku (population, 74,000).

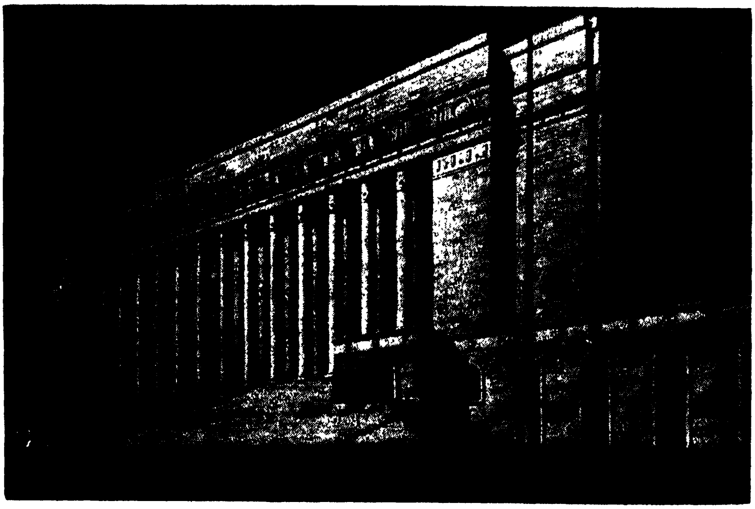
The Finns are thrifty and make the most of their resources. Oats, rye, barley and wheat are grown, as well as hay, potatoes and many vegetables. The forests are a great national resource. Since Finland has no coal or oil, good use is made of water power to generate electricity. There is a great hydroelectric development at the Imatra Rapids of the Vuoksi River. This power station, built by the government in 1921-29, supplies the whole of southern Finland, as far as the city of Helsinki, with electricity.

The chief industrial products are paper and plup, machinery, textiles, leather, furs and chemicals. The Finns have always been noted for their weaving.

Finland gave the vote to women at an early period. Women are admitted freely to all the universities and they have come to form a considerable part of the students in the country's higher institutions of learning. The Finns have always been firm believers in education on a wide scale. At the present time there are three universities, a higher technical school, higher commercial schools, schools to prepare for the universities, training schools for teachers, and special schools for agriculture, dairying, horticulture, forestry, arts and crafts and the like.

During the latter part of the nineteenth century, many novelist, poets and dramatists appeared; there were painters and musicians also. The Finns have always been a musical people, and there are many local choral societies and orchestras. The most noted Finnish composer is Jan Sibelius.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 5997.



Courtesy, Finnish Newspaper

Parliament building at Helsinki. A republic was established in Finland in 1919. The president is chosen for six years, and there is a single legislative body.

Was the universe once a gigantic atom that exploded? That is the theory of Abbé Lemaître.

The PUZZLE *of* SPACE

WHEN we were very small, you and I imagined that space, clear out to the stars, and beyond, was just like the space which closely surrounds us here upon the earth. And we thought of this as "empty" space, in contrast to the space which was taken up by "things" which we could see, like chairs and tables and beds. In other words, we thought of space as empty except where it was filled with visible, material objects. And, of course, before we had thought much about it, we imagined quite wrongly that "air" and "space" were the same thing. "Air" seemed empty to us because we could move through it without any noticeable effort and because we could not see it, or so we thought. We did not realize then that most of the color which we see in the sky—the bright beauty of the sunrise and the sunset; the northern lights with their changing colors, red, green, yellow, white; the colorful flash of shooting stars, and rainbows could not exist if it were not for the very real presence of molecules of gas all around us and above us.

As we grew older, we came to understand that surrounding the earth like a veil is a thin outer layer of mixed gases which we call the air, or the atmosphere, and which is very different from empty space. We call the layer thin. Actually it extends about six hundred miles above the earth. To us, the most important gas in this atmosphere is oxygen, though it is by no means the most abundant. That this atmosphere is really something more than empty space we can prove in various ways. If you light a candle and put it in a bottle and put the cork in, the candle will burn as long as there is oxygen in the bottle; but when the flame of the candle has used up all the oxygen, the candle will go out. When meteors come whizzing through the air above us at rates of many miles a second, they glow with light and color. But we do not see them, even with powerful telescopes, when they are high up above and outside the atmosphere. Why? Because above the atmosphere of the earth they are actually in empty space where there is nothing (or almost nothing), not even air. The meteors glow as they pass through the atmosphere, because they actually come in contact with minute particles of gas which cause friction and tend to heat up the meteors and the gases surrounding them. Out beyond the atmosphere we do not see the meteors because there is nothing out there to cause friction.

LANCELOT HOGBEN CALLS THE ETHER "AN ALL-PERVADING BLANCMANGE"

Now what is it really like, out there beyond this thin atmospheric layer which insulates us from outer space? Until a few years ago astronomers believed in something they called ether—not the anesthetic which the doctor uses, but a kind of mysterious matter which was believed to fill all of space. It was a substance, yet it seemed to offer no resistance to the heavenly bodies as they traveled through the vastness of space. In his fascinating book, SCIENCE FOR THE CITIZEN, Lancelot Hogben speaks amusingly of the early belief that "empty space was accordingly filled with an obliging and all-pervading blancmange called the ether."

OUR ONLY KNOWLEDGE OF HEAVENLY BODIES CAME THROUGH LIGHT

Why did it seem to astronomers that some such obliging and all-pervading medium must exist in space? The answer to this question brings us immediately to the subject of the nature of light. It had long been clear that the only knowledge we have of the heavenly bodies (with the exception of meteorites which we can examine directly) was through the agency of light. It had also been evident, from the time of Galileo on, that only as we learned to analyze the light-rays which reach the earth should we be able to tell anything about the celestial bodies from which these light-rays come! And so, at a very early period of modern astronomy, the astronomer's greatest problem became the devising of instruments and methods by which light could be understood.

NEWTON SUPPOSED THAT LIGHT WAS COMPOSED OF TINY PIECES—"CORPUSCLES"

In the seventeenth century, Sir Isaac Newton developed the theory that light was composed of minute particles shooting out at great speed from the source of light. He called the particles corpuscles, "little bodies." These corpuscles were believed to be infinitesimal bits of actual matter which gave the impression of light when they struck the retina of the eye. This theory was later discarded; and scientists supposed light to be wave-like in nature.

This wave theory held that light was a form of energy. They likened it to waves or ripples moving outward in all directions from the spot where a stone is thrown into a pool. Now, these theorists reasoned, if light moves in waves, there must be some medium, or agency, to carry those waves, as water carries the waves described above, or as air carries the waves of sound. We can not imagine waves which are not waves of *something*. Therefore, the astronomers reasoned, there must be some medium in space, which we can not see or smell or touch, through which these waves of light can move. This medium was given the name "ether"; and it is today often referred to as the "luminiferous" or "light-bearing" ether. The word ether was used by the Greeks for the pure upper air breathed by the gods. But in time the wave theory of light came to be questioned.

Modern science has discovered that light sometimes acts as if it were waves, sometimes as if it were particles. The article on Light will explain this to you more fully.

There are, however, still many unsolved problems in relation to the nature of light. But most scientists today are at least agreed in denying the existence of the ether.

MICHELSON AND MORLEY SEARCHED IN VAIN FOR THE ETHER

Let us see why. In 1887, a famous experiment was performed by the great physicist, Albert A. Michelson, and his colleague, E. W. Morley. By using a very delicate and ingenious instrument invented by Michelson—the interferometer—these scientists were able to determine almost exactly the speed of light, which they found to be about 186,000 miles per second. In their experiments, also, they tried to find out whether there was any real evidence of the existence of that elusive and theoretical substance, ether. They sent beams of light on round-trip journeys from the earth into the ether and back, and measured their speeds. Whether the beams went along with the earth's path, or in a direction opposite to its orbit, or at right angles, the speed was the same. In other words, no stream of ether held back or boosted forward the light as it traveled. There were three possible conclusions which could be reached as a result of the experiments. Either the instruments were not accurate, or the ether dragged along with the earth, or there was no ether. For a long time scientists thought that the ether dragged, or drifted. Today most scientists deny the existence of any such medium as ether.

That leaves us with the question—*what* is out in space? Is the space that surrounds us a vacuum? Or rather, if we could remove from space all material objects such as stars, planets, nebulae, comets and so on, would we have left a vacuum?

SPACE IS FAR FROM BEING A PERFECT VACUUM

Not many years ago, research astronomers of the Carnegie Institution of Washington made an amazing statement about this space which surrounds us and lies between the stars. Although this space comes closer to being a perfect vacuum than anything we can produce upon the earth, they have found that an average cubic yard of "empty" space contains the following:

Twenty million free electrons
Twenty million hydrogen atoms
Five sodium atoms
One potassium atom
Four hundred thousand photons, or "light-darts"

It is necessary to add to all this one calcium atom for every ten cubic yards of interstellar space, and one titanium atom in several hundreds of thousands of cubic yards. In addition, a particle, perhaps as big as an average smoke particle, might conceivably be filtered out of every quintillion cubic yards of the space we find between the stars.

AN ATOM MEETS ANOTHER IN SPACE ABOUT ONCE A YEAR

Another interesting statement on this subject was made by Sir Arthur Eddington—that "an atom encounters another about once a year," in interstellar space.

Dr. Edwin P. Hubble of Mount Wilson Observatory has been quoted as saying that the proportion of matter to space could be approximately indicated by imagining one grain of sand in a hollow sphere the size of the earth. All this matter is called cosmic dust, or interstellar dust.

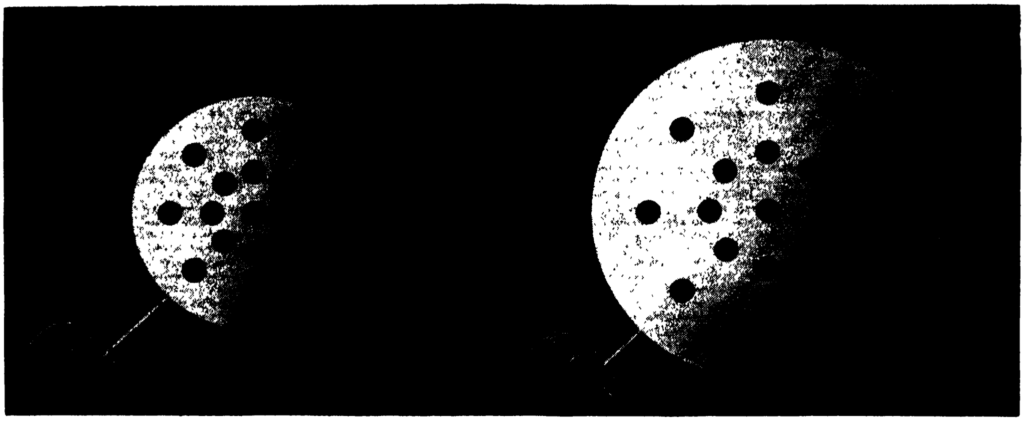
HOW FAR DOES SPACE EXTEND? DOES ANYTHING LIE BEYOND IT?

Now that we have some idea of what outer space is like, we find ourselves considering the question—how far does space extend? Can you imagine it going on forever, in all directions, never ending? It makes one's head ache to try to imagine such a thing. But is it not equally hard to conceive of a finite, limited, universe? (We use the word universe here to mean all space and everything in it—the sum total of galaxies, or island universes.) The question then would be—What lies beyond a finite universe?—for we can not imagine an end to space.

But what do the astronomers say? In order to understand at all what they are trying to make clear, we must rid our minds, as far as we can, of previous ideas, and of established ways of thinking. Even then we shall not progress very far, for the astronomer frankly does not know the answers. It is fascinating to speculate about what the universe may be like as a whole, but we must remember that we are in somewhat the same position as the microbe on the back of a flea on the back of a dog, trying to speculate as to the nature of the universe. We live in one very narrow and isolated corner of the great cosmos. Much of our view is obscured by cosmic dust of one kind or another, and our theories are at best nothing more than guesses, and probably some of them are very wild guesses.

ASTRONOMERS CAN "SEE" 500,000,000 LIGHT YEARS INTO SPACE

If space is infinite, we have no reason to believe that at any particular place matter would cease to exist. It would seem reasonable, therefore, to believe that stars would continue to exist indefinitely in all directions. Our telescopes as yet show no evidence that there is any dropping off of stars numerically with an increase in distance. However, as we produce larger and more powerful telescopes, that very thing may be proved. We can not tell. This is one reason why astronomers are so anxiously awaiting the completion of the 200-inch mirror for the Mount Palomar telescope. At the present time, with the Hooker 100-inch reflector at Mount Wilson, the largest telescope in the world until the 200-inch is finished, astronomers have been able to "see," with the collabora-



If you blow up a balloon that has dots on it, the dots will move farther and farther away from one another as the balloon expands. Something like this seems to be happening in space. Galaxies seem to be rushing away from each other. This theory is called the theory of the expanding universe. The idea of Abbé Lemaitre—that the universe may once have been a gigantic atom that exploded—fits the expanding universe theory quite neatly.

tion of the camera, five hundred million light-years into space in each direction. In other words, they have "seen" into a visible or known universe with a diameter of about one billion light-years, or about one billion times six trillion miles. With the 200-inch instrument we shall be able to see more than twice as far. We shall perhaps (but this is a very large "perhaps") understand by this new evidence more about the shape and real nature of the universe.

One of the most interesting conceptions of the great physicist Albert Einstein is that space is curved. This is hard for the human mind, particularly the untutored and unmathematical mind, to comprehend. The idea is part of Einstein's famous theory of relativity and can not be really understood without extensive mathematical training; but it will perhaps be possible for us in passing to catch a fleeting glimpse of what curved space might mean. If the universe is finite, in other words, does not extend on forever, then space may very possibly be of such a nature that it curves around on itself like an enormous sphere. In this the universe could be said to be finite, but unbounded. If space actually is so curved, then it would be reasonable to assume that rays of light from a star, which start on their way today through the universe, will be curved and bent to fit the form of the universe. In other words, we might be conceivably able to observe with our telescopes the "ghost images" of objects, stars or nebulae or galaxies, which are actually on the opposite side of the universe and which we should have no possible chance of observing directly. In seeing these ghost images we should be doing the same thing as seeing the image of the back of our own heads. You might ask —well, why are we not seeing such ghost images now? Possibly we may be doing so, in some cases. Or possibly the universe is not yet old enough to have given light time to travel halfway around it.

However, we must remember that when the astronomer talks like this, he is simply theorizing, guessing, having fun with ideas which may have no solid basis in fact. In dealing with this whole field of possibilities, we are in the realm of wildest fantasy; but it is fantasy based on possibility.

Professor Einstein in his theory of relativity stated that rays of light are bent from the straight line by objects which exert a gravitational attraction. This statement has been tested and has been accepted by most astronomers. The first successful test was made in the total solar eclipse of 1919. During the total eclipse photographs were made of stars near the sun. You understand, of course, that such daytime photographs can be taken only when the sun is dimmed by an eclipse. The photographs were compared with others taken at night of the same stars at a time of year when the sun was in another sky region. The two sets of photographs were very carefully compared; and it was found that when a star's light comes near the sun, its rays are bent. They are probably pulled out of their straight path by the gravitational pull of that enormous mass of gas, the sun.

Here is another interesting question. If space is infinite, stretching on forever in all directions without stopping, it must contain an infinite amount of matter in the form of stars, interstellar dust and other celestial objects. If this were so, there would be an infinite amount of light, which should make the night sky tremendously brilliant. In this case, also, the gravitational force of all that matter would be tremendous. The force would be so great that we should not be able to measure the comparatively insignificant gravitational pull of individual bodies. But this we are now able to do quite successfully.

To some types of mind it would be more satisfying if the astronomer and the physicist were able to say with certainty "The universe is this and this and this." But to the seekers after truth there is no stimulus so exciting as truth dimly, very dimly, glimpsed ahead through a maze of possibilities.

THE OTHER GALAXIES SEEM TO BE RUSHING AWAY FROM OURS

One of the most interesting conceptions of the universe, and one which at first glance seems as fantastic as Alice in Wonderland, is that of the expanding universe. The great English astronomer, Sir Arthur Eddington, was one of the chief proponents of this idea. He presented it in his book THE EXPANDING UNIVERSE. Doctor Edwin P. Hubble of Mt. Wilson Observatory discovered that almost all of the galaxies, or island universes, or spiral nebulae (by whatever name you may wish to call them) appeared to be receding, or traveling rapidly away from us. This became clearer through a study of spectral lines, which showed that in the case of almost all the galaxies the shift of the spectral lines was toward the red end of the spectrum. (See the explanation of the Doppler effect, page 3202.)

THE EXPANDING UNIVERSE, A THEORY SUGGESTED BY EDDINGTON

It was discovered, furthermore, that the farther away the galaxy, the more rapid its motion. For every additional million light-years of distance from the earth, there was an increase in speed of about a hundred miles per second. At first this seemed so fantastic that hardly anyone could believe that the facts had been interpreted correctly. No astronomer could believe that the earth or the solar system was actually the center of the universe from which all other heavenly bodies were moving away at such great rates of speed. But that was certainly the way it appeared at first.

Sir Arthur Eddington, however, suggested that this general occurrence of the red shift might be the evidence of a universe constantly expanding. If one were to imagine a round toy balloon being farther and farther inflated, each point on the surface of the balloon would be moving away from every other point, and Sir Arthur suggested that some such explanation might account for the general recession of the galaxies. In such an expansion those bodies which are farthest away from the center would move most rapidly. In order to see how this would work, it might be better to think, not of a balloon, but of a solid soft rubber ball which by some means is being blown up. The points on the outside of the ball will be moving more rapidly than those near the middle of the ball.

THE COSMIC ATOM THAT EXPLODED— A THEORY THAT EXPLAINS MANY PUZZLES

Another cosmic theory which neatly fits in with the theory of the expanding universe is that of the Abbé Lemaître of Belgium. He suggests that since all matter seems to be participating in this recession, there must have been a time when all matter was enclosed in a very much smaller space, when the universe itself was of much smaller size. Abbé Lemaître suggested that about two billion years ago all matter was contained within one gigantic atom. An explosion, or splitting, of this primal atom started matter hurrying in all directions away from the center of the explosion. This could very well account for the creation of nebulae, stars, our solar system and cosmic dust. It could account also for the general moving away of all galaxies, and for their increased speed with greater distance. This theory of Abbé Lemaître's would seem to indicate that the stellar universe is not so old as we have thought, and that the solar system and the stars are all of about the same age.

THE UNIVERSE MAY BE EXPANDING AND CONTRACTING BY TURNS

Another idea is that the universe may be pulsating—expanding and contracting alternately.

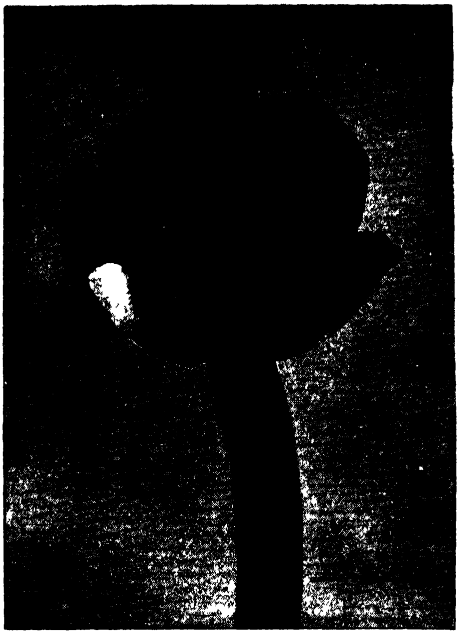
And so, while we have learned many things in the last 6,000 years, during which time man has kept written records, we still know very little with certainty. But with Walt Whitman we can say, as we experience the great and exciting adventures of the questing intellect:

Fearless for unknown shores.
Joyous we too launch out on trackless seas,

By MARIAN LOCKWOOD.

THE NEXT STORY OF THE EARTH IS ON PAGE 6025.

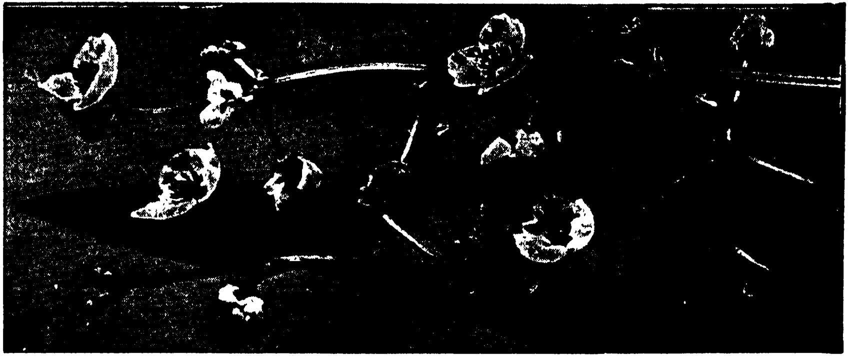
The Water Crowfoot
The water crowfoot is one of the buttercups. The flower is white, and often a sluggish stream will be a mass of white owing to the crowfoot growing in the shallow waters.



The Yellow Water Lily
This flower has an unpleasant odor like alcohol, and in England is called the brandy-bottle. The submerged leaves are thin, but the floating ones thick. The Turks make a drink from the flowers.

The White Water Lily
While the flower of the yellow water lily grows an inch or two above the water, the white water lily is found resting on the surface. Many think that this is our handsomest wild flower.

The Arrowhead
No one can mistake the leaf of the arrowhead, for it is in shape exactly like an arrow. The plant grows in shallow streams near the banks. The white flowers are found in groups of three.



THE FLOWERS OF THE STREAM

ONE general characteristic strikes us when wandering by the stream in search of flowers—that most of the plants are tall and have comparatively slender leaves. This does not apply to those that float or spread their leaves upon the surface of the water; in these the leaves which float on the surface are very broad and greasy to the touch, so that the water rolls off. The advantage of this characteristic is that these plants have their air-mouths on the upper surface of the leaves; it would be harmful to have them blocked up by drops of water.

The plants that stand up along the margins of the stream have two reasons for possessing slender leaves. They grow in crowds, and, as in the case of the grasses, the slender leaf allows a greater number to grow in a narrow space because it enables the light from above to benefit all.

Some plants whose broad leaves float on the surface of the stream have leaves of a very different shape under the water, where breadth would be of no value to them, and where, in order to obtain enough of the small amount of carbon dioxid that is dissolved in the water, they must expose as large a surface as possible to it. This difference between the floating and the submerged leaf is shown well in the Water Crowfoot. This is a buttercup that has taken to living in water. When buttercups are grown from seeds, their first leaves are just the shape of the water crowfoot's floating foliage. In spring many ponds and parts of streams are covered with the crowfoot's white flowers.

If we can get a grown-up friend to hook out a plant, we shall find its stems are very long and soft, and from under-water branches a number of dark green coarse hairs are produced. If, now, we put a piece of the plant into a glass vessel of water, we shall see that these hairs are really the fine divisions of the under-water leaf which spread in all directions; while the round or kidney-shaped floating leaves, which are merely divided into three or five broad lobes, are for the purpose of keeping that end of the plant up, so that the flowers can open in the air. These flowers are very similar in their appearance to those of the buttercups, except that the petals are usually white. We have also a yellow crowfoot which is common in many sections of Canada and the United States.

Before winter comes the water crowfoot has thrown off its floating leaves and withdrawn its living portions largely into the mud, to be safe until spring, when it will again grow.

In the American Frog's Bit, which

prefers still waters, we have a floating plant, for its roots never reach the bottom. The name comes from a Greek word meaning "living in pools." The leaves lie flat on the surface of the water, and are either round or heart-shaped, green above and purplish beneath. Looked at under the microscope they are found to be spongy and put together like so many little nets. The flowers are almost as large as the leaves, with three sepals and three thin white petals.

The frog's bit has no stems to pull it downward to a place of safety, and probably if it remained on the surface, it might be destroyed when the upper waters were turned into thick ice. So in the autumn it sends out short shoots, or runners, and at the end of each develops a bud, which falls off and sinks into the muddy bottom, where it lies quietly all through the winter. In spring it wakes up, swells with growth, and rises to the surface, where it soon puts forth a great number of little floating leaves and roots. It flowers in July.

THE WATER SOLDIER, A NATIVE OF EUROPE

A near relative of the American frog's bit is known as the Water Soldier because all its leaves are sword-shaped, like those of the flag, but their edges are strongly toothed like the edge of a saw. It is a native of Europe, but is frequently seen in aquaria, in which the plants thrive and spread quickly. During the greater part of the year it remains at the bottom. It has flowers like the frog's bit, but larger, and when these are formed the plant rises to the surface.

THE WATER THYME THAT LIVES IN STREAMS AND PONDS

Yet another European relative of the frog's bit is the Water Thyme, which may be found in all sorts of fresh waters. It has long brittle stems that are almost transparent, closely set with short oblong leaves in whorls of threes. The purplish green flowers are very small, and consist of three sepals and three petals. This would be suitable also for aquaria.

THE BEAUTIFUL YELLOW AND WHITE WATER LILIES

The most showy of our floating water flowers are those of the two Water Lilies —yellow and white. In many places both may be found in the same water. They are not usually found where the water is more than fifteen feet deep, and they prefer places where there is no strong current. They are both rooted in the mud of the bottom, and have thick fleshy rootstocks. The large leathery heart-shaped leaves that lie flat on the surface, and do not retain water on top, are much alike in the two species. But the flowers, even apart from their color, are very different.

The yellow water lily never opens wide, but always remains ball-shaped; it is entirely yellow—sepals, petals, stamens and pistil. There are five or six large sepals, inclosing about twenty small and narrow petals, which bear nectar-glands.

The white water lily is not so common as the yellow, and is generally found on larger sheets of water. It has only four sepals, and these are colored green on the outside and white on the inside. They spread wide when the flower is open, and the numerous petals in several rows so dispose themselves that the flower has a very full and attractive appearance. The petals that are next to the sepals are large, and each row becomes smaller toward the centre, so that the only thing that marks them as distinct from the broad stamens is the presence of the anthers. They are to be found from June to September. In the deep woods deer and moose come down to the edges of the lakes to feed upon their succulent roots.

THE ARROWHEAD WHICH EVERYONE CAN RECOGNIZE

Among the plants whose roots are in the bed of the stream with leaves and flowers in the air is the Arrowhead, whose leaves alone will enable us to recognize it though we may never have seen it before. They are of regular arrowhead shape, and while some lie on the surface, others stand up. Those that are submerged are thin and almost transparent.

A tall leafless flowering stem arises from the centre of the arrowhead leaves, and at regular intervals this sends off short branches in threes, each branch ending in a flower nearly an inch across. This consists of three green sepals and three white petals with a purplish base. The lower flowers have no stamens, and are smaller than those above, which have many purple stamens but no pistils.

The pistillate flowers develop into large round fruits. From the swollen

The Bur-reed

The branched bur-reed is a large graceful plant which lives in ditches and ponds. The leaves are sword-shaped, and the flowers of two kinds, some small and olive-colored, others larger and green.

Guinea-hen Flower, or Snake's-head

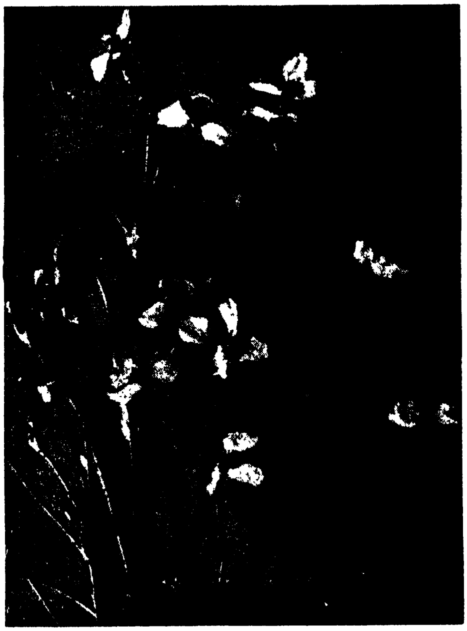
This plant, also called the fritillary, gets the name snake's-head from the fancied resemblance of the bud to a serpent's head. The purple flowers are not unlike tulips, but they droop from the stalks.

The Purple Loosestrife

The purple loosestrife is a handsome plant, and its reddish purple flowers, growing in tall spikes among the rushes of a ditch or stream, might be mistaken for foxgloves at a distance.

The Meadow-sweet

This English meadow-sweet with creamy white fragrant blossoms and handsome foliage is often cultivated in old-fashioned gardens here. The American meadow-sweet is white or pink.



The Water Plantain

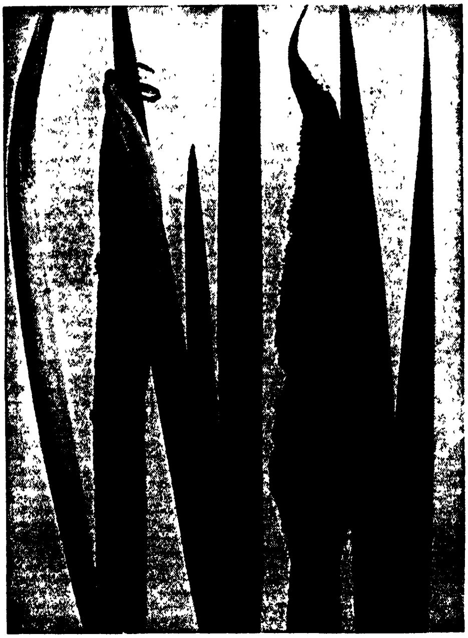
This plant is misnamed. It is no relative of the true plantains, although its large veined leaf is something like that of the greater plantain. The flowers are pink, and the plant is found in water.

The Flowering Rush

The flowering rush, which is not really a rush at all, is an attractive plant with tall stem of rose-pink flowers, growing out of reach of the banks of the European streams. Its flower is its beauty.

The Giant Dock

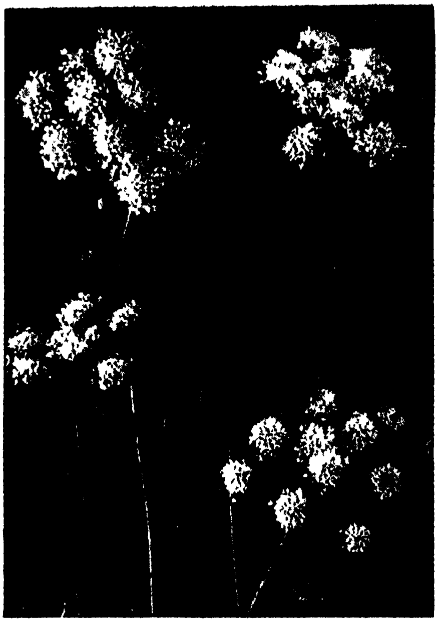
The giant dock, or great water dock, is a picturesque plant frequently found on our river-banks. The lance-shaped leaves are more than a foot long, but the green blossoms are not very attractive.



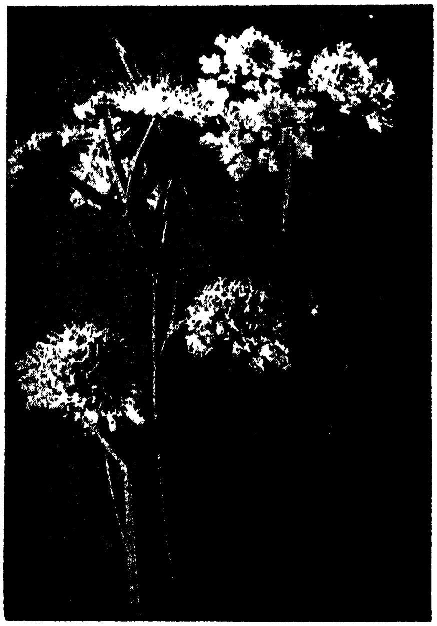
The Cat-tail

The common cat-tail is a stout and tall water plant with flat sheathing leaves that exceed the stem. Its flower is dark brown and velvety, and it is common in the marshes of North America.

The Water Avens
This plant is quite handsome with its slightly drooping flowers, reddish brown in color. The stems and leaves are hairy. Its name comes from a word meaning "oat," and refers to the oat-like fruits.



The Sulphurwort
The sulphurwort, or pepper saxifrage, is not a streamside plant, although it is often found growing in meadows by European streams. The flowers are a dull yellow, and the fruit is dark brown.



The Water Dropwort of Europe
The water dropwort grows on the water, and the lower leaves are submerged, the stems and leafstalks being swollen and hollow. The plant is used as a medicine, but it is harmful if taken wrongly.

The Great Valerian
The root of this plant is attractive to cats, and also to rats, owing to its smell. In the United States, in New York and New Jersey, it has escaped from gardens to roadsides.

base of the plant runners are sent in all directions, and at the ends of these, before the winter comes, tubers will be formed, into which all the materials of leaf and stem will be withdrawn, and next year each tuber will form a separate plant.

THE WATER PLANTAIN IS NOT RELATED TO THE FIELD PLANTAIN

Similar in the shape of its flowers, though much smaller, is the Water Plantain. It is no relative of the plantain of the fields, but belongs to the Arrowhead Family. The flower-stem rises three or four feet above the water, is much branched, and bears a large number of flowers similar to those of the arrowhead, but smaller, and of a pale rosy tint. Each flower is complete, with six stamens and twenty pistils.

THE FLOWERING RUSH WHICH GROWS IN EUROPEAN STREAMS

Another member of the Arrowhead Family is called the Flowering Rush, though it is only rush-like so far as its leaves are concerned. These are three or four feet long, straight and slender, but they grow quite erectly. The flower-scape is as long or longer, and the flowers are clustered in an umbel at the top. Petals and sepals are alike of a fine deep rose color, so that the flower appears to be six-petaled. There are six stamens and six pistils, all of a deep red hue. This is a handsome streamside plant of the Old World.

THE GREAT WATER DOCK, A GIANT IN STATURE

Where we discover the arrowhead we may also come across a giant dock, with broad erect leaves two or three feet long, and a great towering panicle of the quaint reddish green flowers. This is the Great Water Dock, a plant of striking aspect.

THE CAT-TAIL, ONE OF THE FEW DARK BROWN FLOWERS

The leaves of the flowering rush may easily be mistaken for those of the Cat-tail, which many people wrongly call bulrush—another plant altogether. If we trace the leaves of the cat-tail downward, we find their lower parts wrapped round the flowering stem, which is not the case with the flowering rush; otherwise they are much alike in shape and size. The stem, an inch thick, rises to a height of six or seven feet, and the upper foot of it is the flower-spike, the greater portion densely crowded with hundreds of tiny dark brown flowers whose sepals and petals are reduced to mere hairs. The mass of flowers has the appearance of a coat of velvet round the spike.

THE GUINEA-HEN FLOWER, OR SNAKE'S-HEAD, NAMED FOR ITS MARKINGS

That frequent, quaint flower of Europe, the checkered purple Fritillary, or Snake's-head, is found only in American gardens, although similar fritillaries occur in Western North America, and their tiny bulbs are greatly prized by the Indians thereabouts as a food. They belong to the Lily Family, but the flowers are shaped much like small tulips, drooping from the top of slender stems, from which small leaves spring. Their color markings gave rise to the name Guinea-hen Flower.

There is no distinction in shape, size or color between the sepals and petals, alluded to as a six-parted perianth. There are six yellow stamens, and the pistil ends in three stigmas.

THE LOOSESTRIFE IS ONE OF THE TALL STREAM FLOWERS

Returning to our stream, we shall perhaps find Purple Loosestrife, which is also found in Europe, along its bank. It grows to a height of three or four feet, with an angled stem, clothed in lance-shaped leaves, which are usually in pairs, and more or less erect. The upper part of the stem bears whorls of six-petaled flowers red-purple in color. There are twelve stamens and a slender pistil; and in this plant we shall find differences in the length of the stamens similar to those found in the primrose.

THE MEADOW-SWEET, A MEMBER OF THE ROSE FAMILY

The most plentiful of the streamside summer flowers in Europe is the Meadow-sweet, a plant that, judging by the light, foam-like masses of small white flowers, we should not at first sight take to be one of the Rose Family. But if we look at the beautiful divided leaves, we shall remember that they are much like those of the agrimony and silverweed. The American Meadow-sweets have flesh-pink and white flowers, with prominent pink-red stamens.

THE WATER AVENS ARE WIDELY DISTRIBUTED IN AMERICA

Another member of the Rose Family, though not so plentiful as several others, is the Water Avens, closely related to

The Marsh Woundwort
This plant, with its erect stem and flowers of a dull light red growing in a long spike, has a strong odor, though less powerful than that of its relative the hedge woundwort. It is common in marshes.

The Hemp Agrimony
The flowers of the hemp agrimony, which grows in most places in European countries, are much visited by butterflies. They are dull lilac in color, and the plant has an attractive appearance when in bloom.

The Watercress
The watercress belongs to the cabbage family. We all know it as used in salad, but its little white flowers are less known to townsfolk. Introduced into New Zealand, it often stops the streams.

The Yellow Loosestrife
Although the names are similar, this plant is not related to the purple loosestrife, which we see on page 5873. This belongs to the primrose family, and the fine yellow flowers are very conspicuous.

The Water Figwort

European anglers know the water figwort only too well, for their lines become entangled in the seed-vessels of the plant as it grows by the streamside. The round flowers are purplish chocolate.

The Brooklime

This is another member of the figwort family, and is often found growing with the watercress and water parsnip. It was formerly used for gout. The flower is lavender-blue striped with violet.

The Greater Skull-cap

The skull-cap, with bell-shaped flowers of bright blue, growing in a marshy spot, is always attractive. The leaves are lance-shaped with a toothed edge, and the plant often grows to eighteen inches.

The Marsh Carex

This is one of the sedges, which have grass-like leaves and are found growing in various situations, some in rivers and marshes, others in bogs, and others by the seashore. They need damp situations.

The Gipsywort
The flowers of the gipsywort, which are white, dotted with red, are not attractive. It is the leaves, the most conspicuous part of the plant, that draw our attention to it as it grows by water.

The Water Violet
The large lilac flowers of this water violet, each with a yellow centre, are among the most attractive of the Old World blossoms. An American variety has white flowers. It grows near seacoasts.

The Water Mint
Although it is not common, some of us know the pale purple flowers of the water mint, which grows in swamps and roadside ditches. The stems are covered with downy hairs which point downward.

The Shin Leaf
This flower once belonged to the heath family. It now has a family of its own, Pyrola, from the Latin, meaning "little pear," because the leaves are like those of a pear tree.

the common avens, or herb-bennet, of European roadsides. Its leaves are much like those of herb-bennet, which are really on a similar plan of structure to those of meadow-sweet, but with coarser lobes; but the flowers are larger—an inch and a half across—with purple sepals and yellow petals.

THE DROPWORTS INCLUDE THE SULPHURWORTS AND WATER DROPWORTS

There are several of the umbel-bearers known as Dropworts, including in Europe the Sulphurwort, with gray-green, pipe-like stems, and a leaf that is little more than a long pipe-like midrib with a few narrow leaflets on each side. A much larger species is the Hemlock Water Dropwort, which has broader leaves of a more parsley-like form, and small umbels of flowers more widely spread, because their foot-stalks are longer. This is a very poisonous and dangerous plant.

This hemlock-leaved water dropwort must not be confused with the water hemlock, or cowbane, one of the same family, with a similar reputation for poisonous properties. It has a stout rootstock, a tall furrowed stem and large wedge-shaped leaves that are much divided. Although the white flowers are very small, they are massed in large umbels, and the plant as a whole is attractive and imposing.

THE HEMP AGRIMONY IS A RELATIVE OF THE JOE-PYE WEED

A European plant that may appear to have some relationship to these umbel-bearers is the Hemp Agrimony, but it is really a composite. Its flower-heads contain only five or six pale purple tubular florets, instead of the two or three hundred to be found in a head of daisy or dandelion; and these heads form small clusters, which are in turn massed into great clusters at the top of the four-foot stems. The leaves consist of three or five lance-shaped drooping leaflets which are somewhat like the leaves of hemp, while the complete leaf has a resemblance to an elder leaf. It is a close relative of the American boneset and Joe-Pye weed.

THE WATERCRESS WHICH IS USED FOR SALADS

Here and there we come upon a stretch of streamside where, for some reason, no tall plants grow; and here we shall probably find the Watercress, which most of us can recognize by its dark, brownish leaves, which are broken up into roundish leaflets arranged in pairs along the midrib, and the small white flowers are clustered. A glance at the four petals and the seed-vessels will show us that this is a cross-bearer.

THE FORGET-ME-NOT, THAT SEEMS BORROWED FROM THE SKY

With the watercress will probably be the Forget-me-not, with its strangely curled spray of sky-blue flowers, each with a little yellow round the mouth of the flower-tube. It belongs to the same family as the beautiful viper's bugloss. Another relative is the Comfrey, with stems that are from one to two and a half feet high, broad lance-shaped bristly leaves, and large tubular flowers of pale violet color, which hang with their mouths downward.

THE YELLOW LOOSESTRIFE OF THE PRIMROSE FAMILY

There are so many flowers along the streamside that it is impossible to mention them all. There is the tall-growing Yellow Loosestrife, no relative of the purple loosestrife, but a member of the Primrose Family. It has a stem one to two feet in height, with broad lance-shaped leaves and pyramids of bright yellow bell-shaped flowers, though they do not hang as bells do.

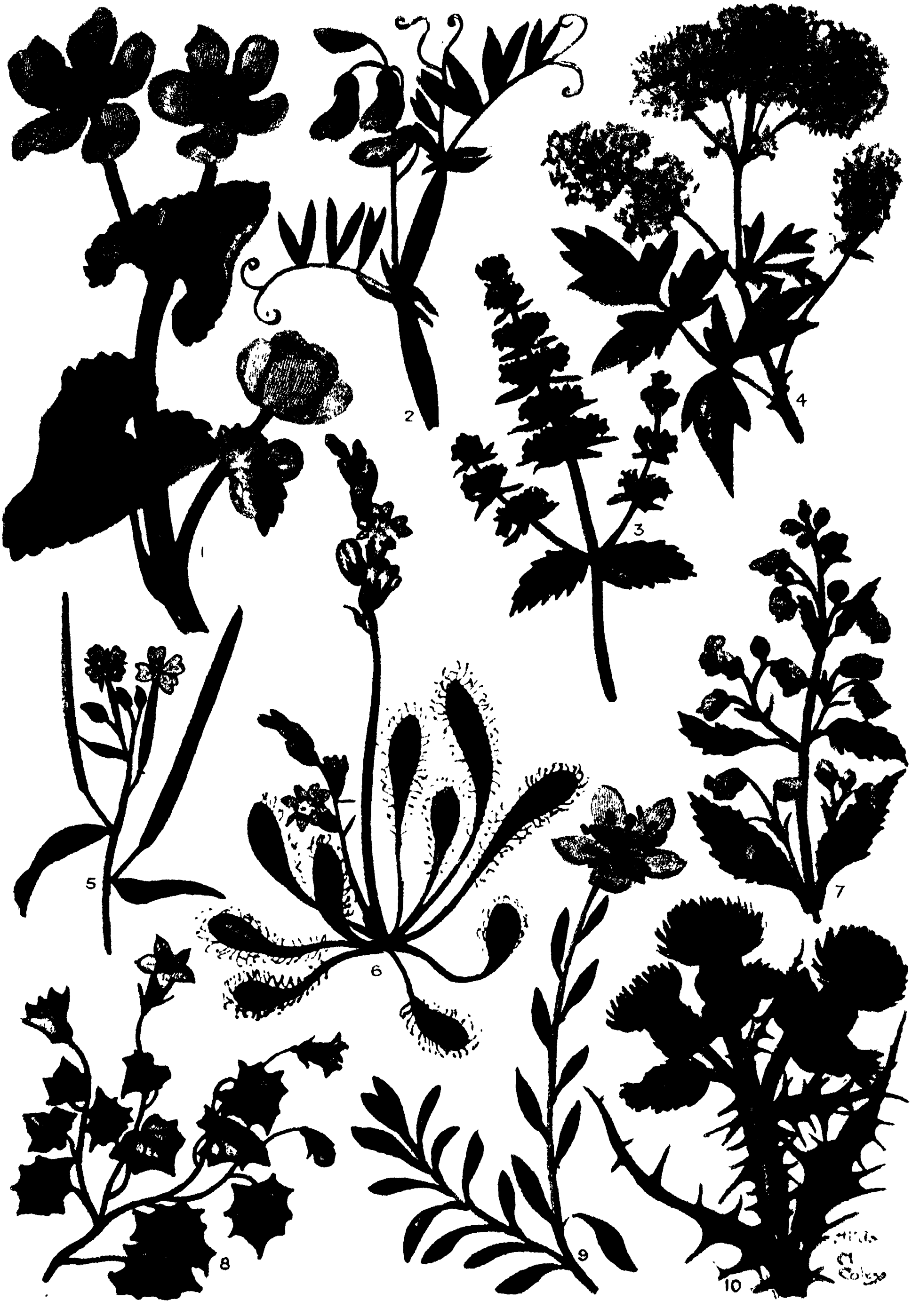
Another tall plant is the Great, or Cat's, Valerian, sometimes found in gardens, whose root-leaves are divided into pairs of lance-shaped leaflets, and whose small pale pink flowers are clustered.

Then there is the Figwort of Europe, with thick square stems six feet high, large oblong leaves, and green and brown flowers shaped like a coal-scuttle, because that shape best suits the heads of wasps, who have a liking for its color and unpleasant smell.

The Labiate, or Mint, Family is represented along the streamside by several kinds of mint, which remind us of their presence by their strong, sweet odor; and by gipsywort, skull-cap and marsh woundwort. Gipsywort has oblong leaves in pairs on its square stem, and whorls of tiny bluish white flowers dotted with purple. Skull-cap, with a similar arrangement of stem and leaves, has its large blue flowers in one-sided pairs. Marsh woundwort is a plant much like hedge woundwort, but shorter, with narrower leaves and paler flowers.

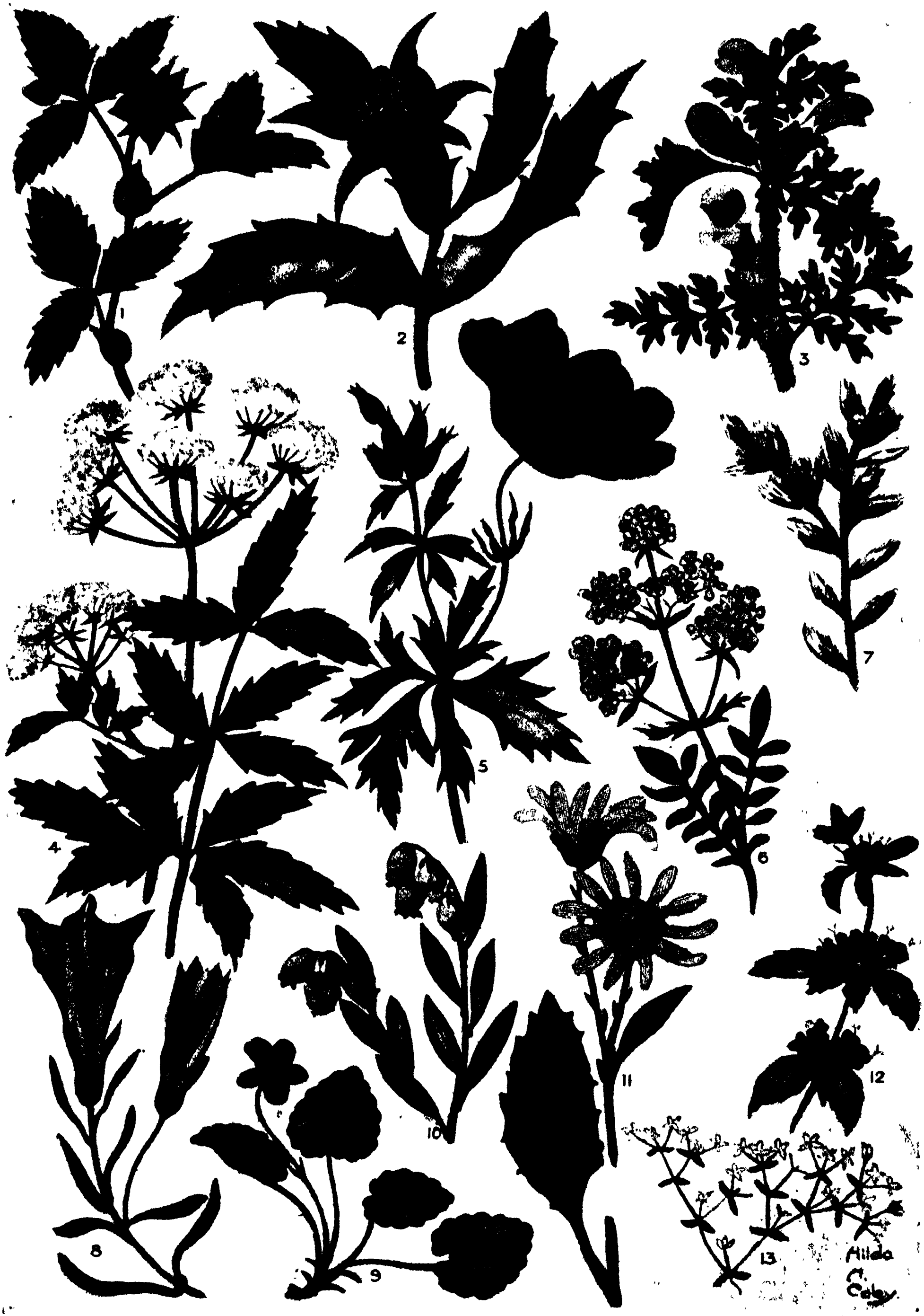
THE NEXT STORY OF PLANT LIFE IS ON PAGE 6125.

FLOWERS OF THE MARSHES



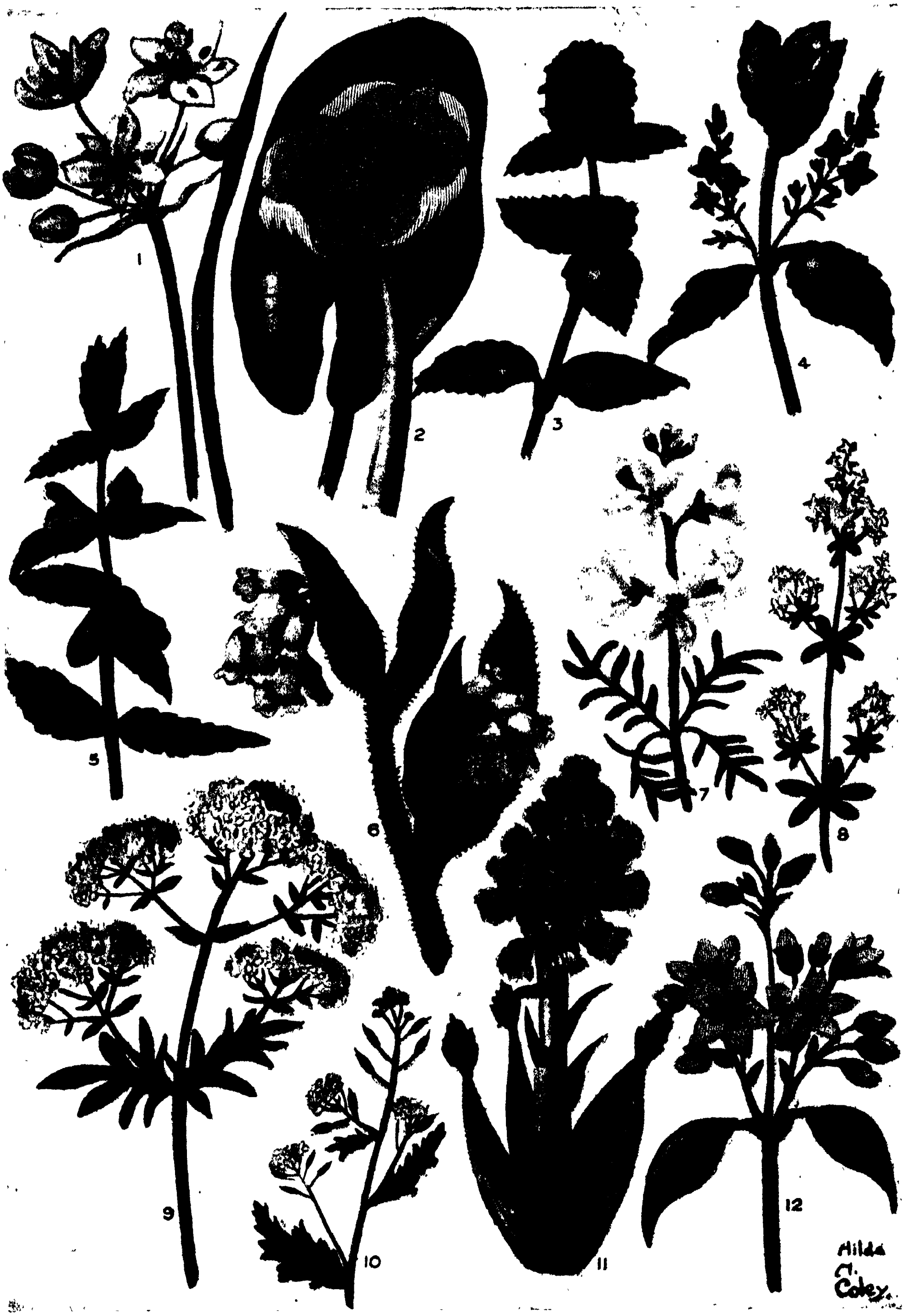
1. Marsh Marigold. 2. Blue Marsh Vetchling. 3. Horse Mint. 4. Yellow Meadow Rue (E.). 5. Marsh Willow-herb. 6. Great Sundew. 7. Knotted Figwort. 8 Ivy-leaved Bellflower (E.). 9. Yellow Saxifrage. 10. Plume Thistle.

Flowers marked (E.) are European and are not generally found in America.



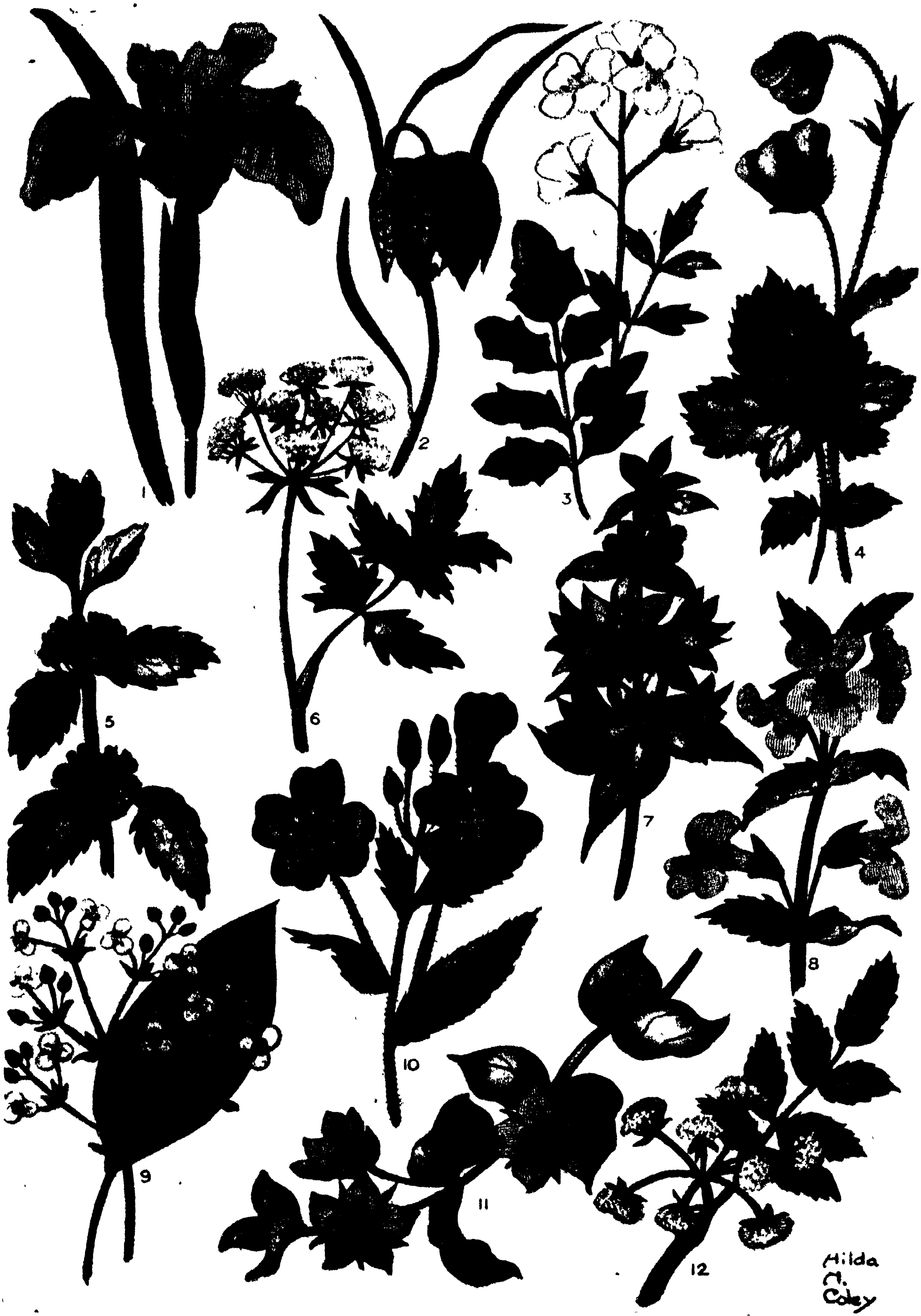
1. Marsh Cinquefoil. 2. Swamp Beggar-ticks. 3. Marsh Red-rattle (E.). 4. Water Hemlock. 5. Meadow Cranesbill. 6. Swamp Valerian. 7. Marsh Cudweed (E.). 8. Marsh Gentian (E.). 9. Marsh Violet. 10. Marsh Andromeda. 11. Marsh Ragwort. 12. Pennyroyal (E.). 13. Flaxseed (E.).

FLOWERS OF THE STREAM

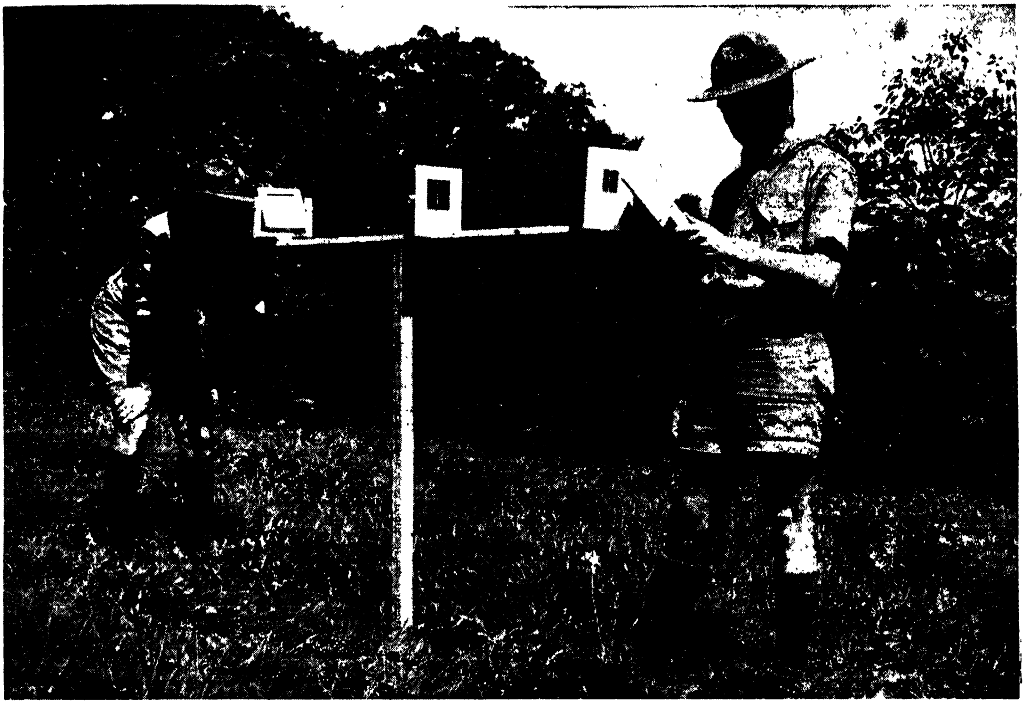


1. Flowering Rush (E.). 2. Yellow Water Lily. 3. Water Mint. 4. Brooklime. 5. Greater Skullcap. 6. Common Comfrey. 7. Water Violet (E.). 8. Water Bedstraw. 9. Great Valerian. 10. Marsh Yellow Cress. 11. Common Butterbur. 12. Yellow Loosestrife.

Flowers marked (E.) are European and are not generally found in America.



1. Yellow Iris 2. Snake's Head. 3. Large-flowered Bitter Cress. 4. Water Avens. 5. Marsh Whorled Mint. 6. Water Parsnip. 7. Purple Loosestrife. 8. Yellow Monkey Flower. 9. Water-plantain. 10. Willow-herb. 11. Moneywort. 12. Procumbent Marshwort (E.).



1. Two Boy Scouts operating a heliograph. The boy at the right is sending a message in code by cutting off, at certain intervals of time, the ray of light that is reflected from the station mirror, at the left.

HOW TO MAKE A HELIOGRAPH

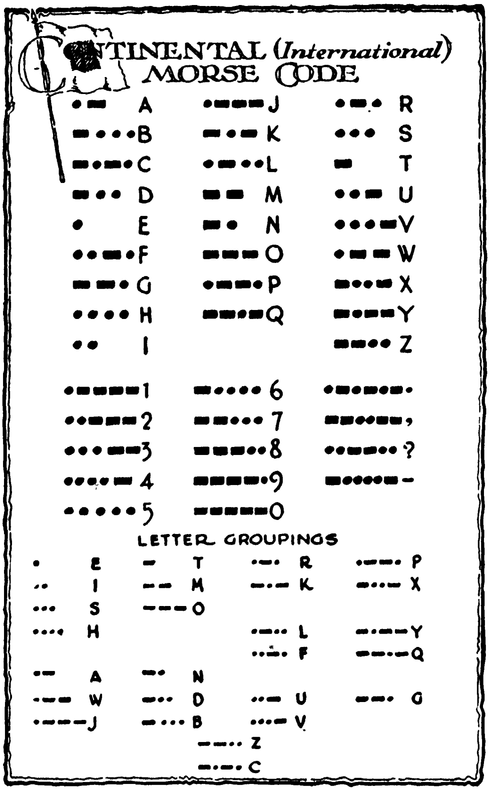
THE heliograph (heel′-ee-oh-graff) that we are going to describe is an ingenious device for sending messages over considerable distances. It requires no batteries or wires; it may be constructed from a few scraps of lumber, a hand mirror, several bits of wire and a few nuts and bolts.

What is a heliograph? Let us examine the word. It comes from two Greek words—*helios,* meaning sun, and *graphein,* meaning to write or send a message. The heliograph, you see, uses the rays of the sun to send a message. The sun is such a strong source of light that the flashes of the heliograph are visible for great distances. In the clear atmosphere of western United States, signals have been sent by the heliographs of government surveying parties to points a hundred miles distant.

The heliograph works by directing the rays of the sun, in a series of long and short flashes, to a receiving station. The long and short flashes correspond to the dashes and dots of the Continental or International Morse Code. We give this code in Figure 2. If you are a Boy Scout, you may be familiar with it. If not, you will find that it is not really difficult to learn the code, particularly if you group the letters as suggested in Figure 2.

The simplest sort of heliograph is a hand mirror, arranged in such a way that it is focused on a definite spot. The intervals between flashes are produced by putting the hand in front of the mirror so as to shut off the rays of the sun. The hand mirror is effective, however, only at short distances. For one thing, it is very hard to keep the flash focused in one place. Unless the mirror is very carefully focused, the person at the receiving end may not see any flash at all.

In this article we shall tell you how to make a heliograph by which you can signal to somebody miles away. The design of the heliograph is shown in Figure 4. You will note that the heliograph rests on an upright


CONTINENTAL (International) MORSE CODE
•— A
—•••B
—•—•C
—•• D
• E
••—•F
——•G
•••• H
•• I
•———J
—•— K
•—••L
—— M
—• N
———O
•——•P
——•—Q
•—• R
••• S
— T
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LETTER GROUPINGS
• E
•• I
••• S
•••• H
•— A
•—— W
•———J
— T
—— M
——— O
—• N
—•• D
—••• B
——•• Z
—•—• C
•—• R
—•— K
•—•• L
••—• F
••— U
•••— V
•——• P
—••— X
—•——Y
——•—Q
——• G

2. The Continental or International Morse Code, used in operating the heliograph that is described in this article. You will find it easier to memorize the letters of the code if you learn them in the order shown under "Letter Groupings," above.

stake sharpened at one end so that it may be driven into the ground. This upright should be 4 or 5 feet long; either 2″ x 4″ (that is, two-inch by four-inch) or 4″ x 4″ (four-inch by four-inch) lumber is used. A piece of 2″ x 4″ lumber, 6 or 7 feet long, is fastened at the centre, flat side uppermost, to the top of the upright by a large screw. The horizontal piece should be left free to turn in any direction.

In Figures 3 and 4 we show the station mirror, so called because it is permanently attached to the horizontal piece. A good piece of plate glass mirror, 4 inches square, should be used for the station mirror. At the exact centre of the mirror, you must scratch away enough silver from the back to make a small peephole, which should not be more than ⅜ of an inch in diameter.

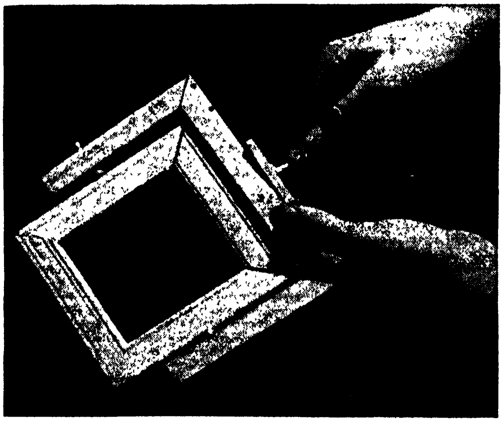
The mirror is set in a frame made of picture molding. The framed mirror is mounted in a U-shaped easel, made of 1″ x 1″ lumber. First, holes are drilled in the centre of the upright ends of the easel. Then, the mirror frame is attached to the easel by means of large nails, inserted through the holes that have just been drilled.

Some spring arrangement, like that which is shown in B, Figure 4, should be worked out, so that the mirror may be set rigidly at any angle. The easel is now bolted to one end of the heliograph frame. Several washers should be used on the bolt between the 2″ x 4″ and the easel.

Next, we are to make the two diaphragms (dy′-ah-frams), which are shown in Figure 4. The word diaphragm is used of any device that narrows the field of any lens or reflector. In the case of our heliograph the diaphragms serve to cut the beam of light reflected from the mirror in such a way that it becomes a brilliant flash.

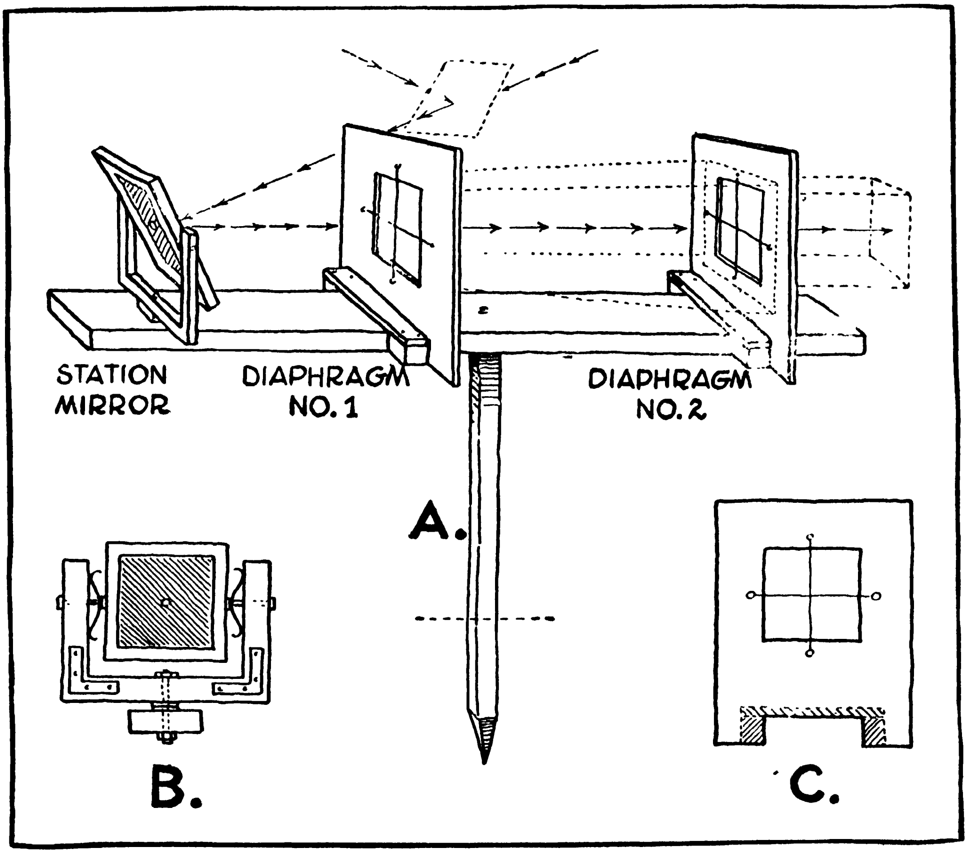
The diaphragms may be made of tin, cardboard or light wood. They are made the same size—8″ x 12″, with the 8″ side on top. They are cut away at the bottom, as shown in Figure 4, so that they may slide along the horizontal piece of the heliograph frame. They are balanced and supported by a piece of wood to which several blocks are nailed, as indicated in the diagram.

A hole 3 inches square is cut in the centre of Diaphragm No. 1. Accurate cross wires (string may also be used) are rigged across the hole, as in Figure 4; the cross wires meet at the exact centre of the hole. Diaphragm No. 2 is prepared in the same way, except that the hole in the centre of the diaphragm is only 2 inches square, instead of 3.



3. A close-up of the station mirror assembly. This picture shows you the U-shaped easel, the mirror frame and the station mirror, set in position.

This is how the heliograph is operated. Look through the peephole of the mirror and adjust the horizontal piece of the framework and the two diaphragms so that the receiving station will appear right where the two wires cross in each diaphragm. Now hold a sheet of paper over Diaphragm No. 1 and twist the station mirror until the dark spot formed by the peephole comes to rest at the place where the wires cross.



4. This diagram shows you some of the details of the heliograph. A shows you the heliograph assembly, complete with station mirror and two diaphragms. The arrows pointing downward show how the sun's rays hit the station mirror; the arrows leading away from the station mirror show how the ray of light is reflected from the mirror. The dotted line, at right angles to the upright, indicates how far the upright is to be driven into the ground. B shows the station mirror assembly. C is a close-up of a diaphragm.

In order to signal, you must be able to shut off the rays of the sun by means of a shutter held in front of Diaphragm No. 2. You may use a sheet of cardboard or hat for this purpose (the boy in the foreground in Figure 1 is using a square of heavy cardboard mounted on a wooden handle). A permanent shutter, which will slide up or down, can be attached without difficulty to the horizontal piece of the heliograph.

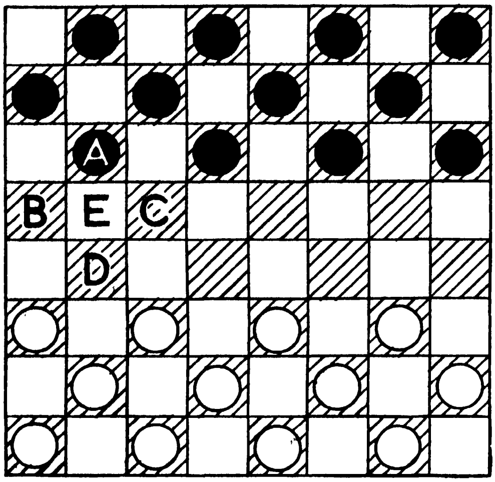
By means of the shutter you will be able to make a series of short and long flashes that will correspond to the dots and dashes of the International Morse Code. Do not go too rapidly. Count three while making a dot and six while making a dash.

If the sun is behind you when you are sending, you will need an additional mirror. One member of the signal party can hold this mirror and reflect a beam of light onto the station mirror. The heliograph may be provided with a flexible arm attachment, so that the second mirror may be clamped to the heliograph frame when needed.

· Article and illustrations, courtesy of the Boy Scouts of America.

THE GAME OF CHECKERS

THE game of checkers is so simple that a child can learn to play it. Yet it is a very scientific game and one with fascinating possibilities. An expert who had spent a lifetime in studying checkers once confessed that he, a champion checkers player, had only begun to "touch the fringe of the subject."

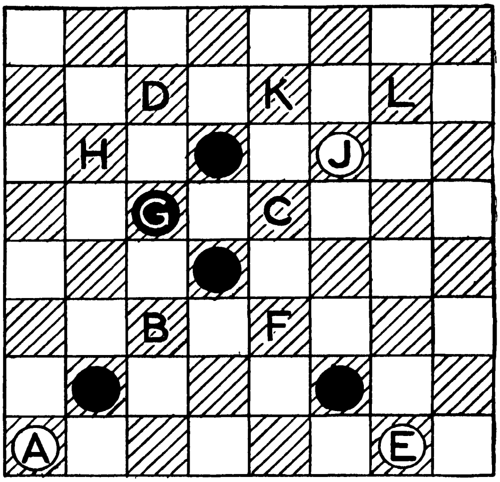


1. Diagram showing how the checker pieces are to be set up on the board at the beginning of a game.

The rules of the game are simple enough. The game is played on a board like that shown in the illustrations. As you see, this board has 64 squares, 32 of a light color and the rest of some dark color (generally red or black). The light-colored squares are always referred to as white and the dark-colored squares as black. There are 24 pieces or men, 12 white (or some other light color) and 12 black (or some other dark color). The checker pieces are discs made of wood or bone or ivory.

When he is setting up the pieces for a game, each player should be sure that the side of the board nearest him has a white square in the right-hand corner. Each player takes one of the sets of men; the pieces are arranged as shown in Figure 1. The pieces, as you see, are placed on the black squares to start with; they are never moved to any of the white squares.

The two players take turns moving; each player takes one move at a time. Each piece may be moved forward a single square in a diagonal direction. Thus piece A in Figure 1 can move to B or C, but must not move across the white square E in order to reach D. However, if our opponent's piece is in the black square ahead of our piece, we jump over the opponent's piece, land in the vacant square and remove from the board the piece over which we have just jumped. If, after jumping over a piece into the square beyond, we come to another of our opponent's pieces with a vacant square beyond that, we can jump over this second piece and remove it also from the board. Even more men can be captured at a single move.



2. Diagram illustrating the different moves that can be made by the pieces in the course of a game.

Figure 2 illustrates some of the moves of checkers. We can move the white piece at A to space B, then to space C and finally to space D, taking three of the black pieces on the way. The white piece at E can move to F, taking off a single black piece; but it can not move to H, because there are two black pieces in the way. When we do not capture an opponent's piece in moving, we can move only to the next square. Thus, in Figure 2, piece J can move only to K or L.

When a piece reaches one of the four squares at the opposite side of the board, it becomes a *king*. (The four end squares make up the *king row*.) The king is *crowned* by having another piece of the same color placed on top of it. The king can move either forward or backward—always diagonally—one square at a time except, as before, when jumping over an opponent's piece.

An ordinary piece can take off only three men at most; after taking the third piece it comes to the last or next-to-the-last row of the board. But since a king can move backward as well as forward, it can take off more than three men at a time. This does not happen often, particularly when well-matched opponents are playing.

When an ordinary piece lands in the king row, it can not move or jump again until the opponent has made another move. A king, however, can jump into a king row and right out again as long as there is any piece on the board in a position to be taken.

The object of the game is to take all our opponent's pieces or to block them in such a way that they can not move without being taken off. If each of the two players has only one king left or two kings left (rarely more) and the pieces are not blocked, a tie game results.

The choice of color is decided by lot; black always moves first. The opponents change pieces after each game; thus, player A first plays the white men, then the black, then the white and so on. If a piece is touched, it must be moved, if that is possible. (Sometimes, of course, its path is blocked by other pieces.)

If a player has a jump before him but fails to take it, making some other move instead, his opponent can do one of three things. (1) He can let the first player's move stand. (2) He can compel the first player to take back the wrong move and to make the jump. (3) He can *huff* the piece that should have made the jump; that is, he can remove it from the board. After that, he is entitled to move one of his own men.

The use of the word huff here is very interesting. One of the rules of the game is that in a regular checkers match there must be no talking whatever. Therefore, to show that he is removing an opponent's piece for not jumping, the player picks this piece up, passes it near his mouth, blows upon it and places it on his side of the table—all without saying a word.

Now, another word for blowing is huffing. Therefore, the action of blowing on a piece to show that it is to be removed for not jumping came to be known as huffing. Nowadays the word huffing refers to the removal of the piece rather than to the actual blowing. Only in regular matches or tournaments does blowing take place.

Boys and girls can have a lot of fun at checkers even if they are not very skillful at the game. However, the more deeply they get into it, the more they find that there is to learn. There are all sorts of openings, all sorts of combinations, all sorts of traps to be avoided. When a young checkers player has mastered the moves of the game, it would be well for him to get a checkers manual and to make a study of the many possibilities of checkers. He will find the following books very useful: Checkers by Leonard G. Frill, Let's Play Checkers by Kenneth M. Grover and Champion Checkers by Arthur Reisman.

A USEFUL HECTOGRAPH

THE word hectograph comes from the Greek words for hundred and write. A hectograph, therefore, is a device for making a number of copies (not necessarily a hundred, of course) of a written page.

To construct a simple hectograph, first provide yourself with a good-sized shallow tin dish; a square cake tin or the lid of a bread box will serve the purpose very well. You will also need 1 ounce of gelatin, 1 ounce of brown sugar, 6 ounces of glycerin and 2½ ounces of barium sulphate.

Cut the gelatin into small pieces and put them into a saucepan with three ounces of water. Let this stand overnight. In the morning pour in the glycerin and heat the mixture over a slow fire. Then put in the sugar and keep the mixture hot until the sugar is dissolved. Mix the barium sulphate thoroughly with 1 ounce of water in a cup and pour this into the saucepan. Stir thoroughly until the ingredients are well mixed. Now pour this batter into your flat tin dish, which should be spotlessly clean. When the mixture is jellied and firm, it is ready for use. It will have a flat surface like soft rubber.

This is how the hectograph is used. Write on highly glazed paper, with special hectograph ink, the message that you wish to duplicate. When the writing is dry, place the paper face downward on the hectograph. Be careful not to have wrinkles on the paper. Then rub the back of the paper with your fingers, so as to press the writing upon the face of the jelly. Remove the paper after five or ten minutes. The writing will appear on the surface.

Now you are to provide yourself with the sheets of paper on which the copies are to be made; this paper should not be highly glazed. Press the sheets, one after the other, on the hectograph surface for a few seconds. The writing on the hectograph will appear upon the paper. You will be able to make fifty copies or thereabouts before the ink becomes too faint.

Before the hectograph is used to make copies of other material, it must be cleaned thoroughly. Wash it first with a little water mixed with an eighth part of hydrochloric acid, and then with pure water. Then let it stand for at least twelve hours before it is put in use again.

HOW TO CONDUCT A TOURNAMENT

IN the Middle Ages a tournament was a mock fight between nobles, usually on horseback. It was a sort of imitation battle, sometimes fought on a grand scale, one party against another; sometimes in single combat. Only men of high degree were permitted to enter the contests, and the winners were given costly prizes and, in certain cases, royal favors.

A modern tournament is a contest in a field of sport to determine who is the best player. A country club often conducts tournaments in tennis, golf and other games, at the end of the summer. Spring tournaments are popular in schools and colleges. Sports tournaments are managed according to exact rules, and all those who enter must be willing to abide by these rules.

In arranging a tournament, the simplest form of schedule is as follows: The contestants give their names to the manager, who then pairs the names off for playing the first round by drawing cards out of a hat or some such method. We then have:

FIRST ROUND

	Winners
A plays B	A
C plays D	D
E plays F	F
G plays H	H
I plays J	I
K plays L	L
M plays N	M
O plays P	O
Q plays R	R
S plays T	S
U plays V	V
W plays X	X
Y plays Z	Z
AA plays BB	BB
CC plays DD	DD
EE plays FF	FF

Let us suppose that the winners of the first round of our tournament are A, D, F, H, I, L, M, O, R, S, V, X, Z, BB, DD and FF. The losers of the first round are now eliminated. By that we mean that they are out of the tournament.

In the second round the winners of the first round will be matched against each other, and in the next rounds the winners of the previous matches play.

SECOND ROUND

	Winners
A plays D	A
F plays H	H
I plays L	I
M plays O	O
R plays S	R
V plays X	X
Z plays BB	Z
DD plays FF	FF

THIRD ROUND

	Winners
A plays H	A
I plays O	O
R plays X	X
Z plays FF	Z

FOURTH ROUND

	Winners
A plays O	A
X plays Z	X

There will be as many rounds as will be necessary to eliminate every player but one. The next to the last match is called the semi-final; the one before it, the quarter-final. The last one, of course, is the final. That is the big event, determining the championship of the country club or school or college or group which is conducting the tournament.

The winners of our semi-final, as you see, are A and X. They play the final match and if A wins, then A is the champion and will receive the honors of the occasion. Perhaps the award is a silver cup, on which the name and date and the winner's name are engraved. Often a second prize is provided for the loser of the final.

In many cases the winner of a tournament is given a silver cup to keep for only a year or two; then the cup must be returned and contested for all over again. When a player wins it in three tournaments, he may keep the trophy as a permanent possession. The first time he wins, he is said to have secured *one leg* on the cup; the second time, *two legs*. When a cup becomes the permanent possession of a player, the club provides another cup as a prize for its next tournament.

The tournament as arranged above is suitable when the players are fairly evenly matched. But in your school, for example, you may have two or more very fine tennis players and many others of ordinary skill. If A and B are both particularly good players and you match them together in the first round, one or the other will be beaten and will drop out of the tournament at the very start. That will be unfortunate, as you would like to have the most exciting matches come at the end.

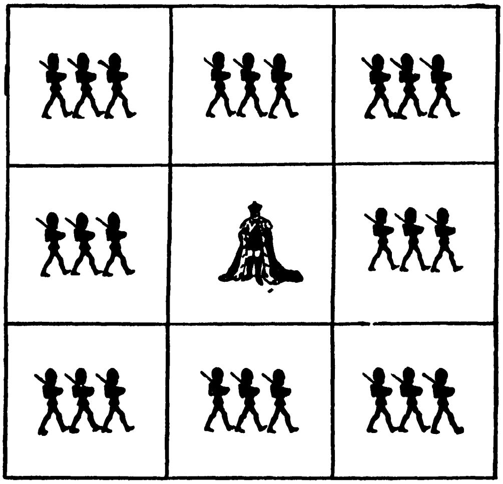
In such a case you must not trust to chance in pairing off the players. You must *seed* the entries; that is, you must arrange the first rounds so that A and B will not play together before the final or semi-final. If A and B survive all their matches, your final will be a thrilling combat between two players of nearly equal ability. If either A or B is beaten, you can be fairly certain that the victor is also a superior player and will provide plenty of competition in the final.

The time and place of each match must be posted well in advance. A player who accepts the time given and then does not arrive is said to lose the event *by default*. However, a postponement may be arranged, with the consent of both contestants, because of weather or other conditions.

THE PUZZLE OF THE KING'S GUARD

A CERTAIN king was staying at one of his hunting lodges in the forest. In this house there were nine rooms, laid out, as shown in the diagram, so as to form a square. The king slept in the central room, and he arranged that the twenty-four soldiers who formed his guard should be stationed in the eight outer rooms, in such a way that there should be nine soldiers on each side of the house. The soldiers were stationed just as you see in the diagram—three in each room.

One day a soldier asked the king if his comrades and he could meet on different evenings in one another's rooms. The king agreed to this, but only on the condition that there should always be nine soldiers on each side of the house. Before retiring on the night that this new arrangement was made, the monarch thought that he would go around the lodge and count the soldiers on each side, to see that his orders were being obeyed. He wanted to be sure that none of the soldiers had gone to the village close by or had allowed any strangers to visit them in the lodge. He looked carefully around and found that there were just nine men on each side of the house. He went to sleep with the comforting feeling that his men were all there.



And yet four of them had gone to the village and were not in the house. The next night none of the soldiers went to the village; but four of the villagers came to the hunting lodge and were let in. When the king made his evening tour of inspection, he thought that all was well; he counted nine men on each side of the lodge. On the third night eight visitors came in, and now there were thirty-two men in the house. However the king still counted nine on each side of the house.

On the fourth night the soldiers invited no less than twelve of their friends. It was apparently difficult to arrange the thirty-six men so that there would still be nine on each side of the house, but the soldiers found a way. On the fifth night six of the soldiers slipped away to the village, leaving only eighteen of their comrades on guard. Yet these eighteen so arranged themselves that, as before, there were exactly nine on each side of the lodge.

How did the soldiers manage to keep the same number of men on each side of the lodge, although the number of individuals in it varied so greatly? The solution to this interesting puzzle is given on this page in reversed (upside down) type.

SOLUTION OF THE KING'S GUARD PUZZLE

The five diagrams that we give below will show how the men in the King's Guard puzzle were arranged in each one of the five cases that we presented.

1.

4	1	4
1		1
4	1	4

2.

2	5	2
5		5
2	5	2

3.

1	7	1
7		7
1	7	1

4.

	9	
9		9
	9	

5.

5		4
4		5

A MIND-READING TRICK

HERE is a very simple trick that is quite mystifying until one knows just how it is done. You tell a friend of yours that you are going to read his mind. First of all, you put your watch down on the table. You remark, as you do so, that it's no use wasting too much time on mind reading; therefore you're going to time yourself when you start reading his mind.

Now ask your friend to choose a number from one to ten. Tell him that you are going to tap on the table with a pencil and that he is to count the number of taps—he must not count out loud, but to himself. He must not begin with one. He is to begin with the number next highest to the one that he has chosen. For example, let us say that he has selected the number five. In that case, he will say "Six" to himself as you tap for the first time; he will say "Seven" as you tap for the second time and so on. When he reaches the number twenty, he cries "Stop!"

It is now up to you to tell him what number he had in mind to begin with. "It is now just—" and then you look at the time. "Yes, it's just five minutes past nine. If I can't guess this trick in less than a minute, I'll have to admit that I'm not as good a mind reader as I used to be." You now assume an air of deep thought, mumbling to yourself: "Seven, five, nine" and a lot of other numbers chosen at random. You look anxiously at the watch every now and then. At last, just before the minute is up, you say triumphantly: "I have it!" And sure enough, you're right. You'll always be right, no matter how often the trick is repeated.

Yes, it really is a trick and not a mind reading performance. Here is how it works. When you begin tapping, you count to yourself—one for each tap. One, two, three, four, five, six, seven. Easy, isn't it? Now when you get to eight, you look at the figure twelve on the dial of your watch. When you get to nine, you look at the preceding figure on the dial, which is eleven. When you get to ten, you look at ten and so on. When your friend says "Stop," the number on the watch dial that you looked at when you tapped last is the number that your friend was thinking of. If you are careful to keep the right number in mind, the trick can not go wrong.

Of course you could have told him the number at once, but the trick is more effective if you pretend to think things over.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 5977.

The Blue Shark.

FISHES OF THE DEEP SEA

We have tracked life all over the earth: limbed life, winged life; up the mountains, down the valleys, from tree-tops to the silent cavern and the mountain's hollow heart; and, in company with life that draws its breath in fluid form, we have floated with the current, down streams to the ocean's margin, and peeped at existence in the shallows.

And now the story must be renewed in the appalling deeps. Down in the deep sea is life abounding, strange and even loathsome, with here and there such radiant beauty as is not to be explained by human intelligence.

Only a selection of this vast sea assembly could be discussed, even if a whole volume were at our disposal. As it is, we can only look rapidly at some of the things which a nightmare alone could suggest if we did not know that they existed. First, then, the Sharks, whose near kindred, the rays, have already been mentioned.

To say that they are the tigers of the deep is not quite true. The sharks number in the family giants which, like those mammalian monsters the whales, are guiltless of offense against man unless themselves attacked by him. The Whale Shark and the Basking Shark are content with a simple, if extensive, diet of small fish, far out at sea.

The Dogfish nearer home are sharks also, but they are harmless to us because they are too small to be deadly. They have been a plague to our fishermen, preying on fish wanted as human food, breaking the fishermen's lines, and cutting the nets with their sharp teeth. Because they had so unattractive a name they were not regarded as fit to eat. Under the new name of Grayfish or Rock Salmon, the dogfish come to land as fish of excellent quality for frying, and yield an oil which, as the doctors tell us, is second in value only to cod-liver oil. Then, too, their spiny skins furnish the shagreen of commerce. Cabinet-makers use it for polishing wood.

Many species of sharks are man-eaters, find them where we may. The Whale Shark of the Indian Ocean is sometimes sixty feet long and is the second largest animal in the world. We may be thankful it is a peaceful beast. But the terrible White Sharks run to as much as forty feet, with great teeth, not in one row to the jaw, as ours are, but row behind row, so that as one set wears down, the one behind moves forward, rendering the shark always fully equipped for battle.

Very ancient are the sharks. Their huge frames are mounted, not on a skeleton of bone, as is the case with most fish, but on a skeleton of exceedingly tough cartilage. When they die little but their teeth remains to attest their past. Taking teeth as a guide, it has been found by deep-sea dredging that the sharks of olden time were monsters in comparison with which present-day types are insignificant. So they, like the reptiles and the former mammals, had their giant age.

While all sharks are carnivorous, not all of them attack man. From the list of offenders we may rule out several. There is the Port Jackson Shark, common to the seas of Australia, to Japan and to California. This is an innocent one, and its teeth, arranged in series, are adapted to crushing up the shells of molluscs, and on the contents of these it feeds. The Zebra Shark of the Indian Ocean, ten or fifteen feet in length, keeps well out at sea, so has a clean sheet as far as humanity is concerned. The Fringed-gilled Shark of Japan is too small to be hurtful to us, as are the three known species of *Crossorhinus* from the same latitudes. These sharks have extraordinary leaf-like filaments about their heads. They look like a rock covered with vegetable growth, and unsuspecting fish approach them. They are harmless to man.

HOW THE THRESHER SHARK MAKES SURE OF A BIG MEAL

The Porbeagle Shark, so named from its supposed resemblance to the porpoises, is a ten-footer, a fish-eater with an appetite, but is occasionally known to assail men. The Fox Shark, or Thresher, well known in European waters, is a fisherman bold, but thanks to its small mouth it escapes condemnation. The name of thresher it derives from its habit of threshing the water when the shoal which it is pursuing tends to scatter. A thwack of the long high-lobed tail on the surface of the water and the fish scurry together—safety in numbers as the herd instinct teaches—and are then taken in mouthfuls.

We are left, then, with such demons as the white shark, the Greenland shark, the blue shark and the hammerheads, and the greatest foe of these is the first. As we all know, the mouth of most sharks is placed on the under-side of the head. It would be worth while to discuss this curious design if we knew its meaning, but we do not. It has one blessed result, that the shark must turn over to bite a big object, and to that fact many a bold human swimmer has owed his life.

Sharks do not always turn in this way to bite, because it may not be necessary to do so. The Hammerhead never does, for the reason that its mouth is placed far in advance of the ordinary shark mouth. Indeed, the structure of this creature is unique. The head is broadened out and flattened, expanding on each side into a lobe, each bearing one of the eyes. But freakish though he seems, the hammerhead is one of the fiercest of all the sharks and is the dread of every man who is compelled to enter deep water in the Indian Ocean.

BEASTS OF PREY THAT PROWL THE SEAS LIKE HYENAS IN THE JUNGLE

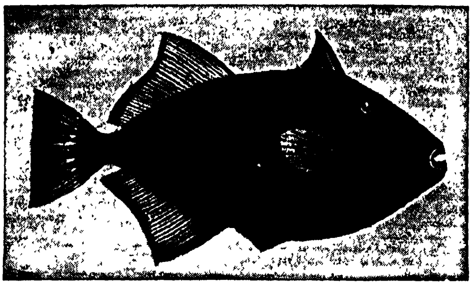
Still, this one is not as terrible as the great White Shark, which can bite off a man's leg or sever his body at one snap of its terrible jaws. The Greenland Shark is another ferocious foe to man, but it hunts the whale as a rule, tearing out the giant's tongue or ripping its live flesh from its body. Ordinarily alert and wary, it is so ravenous a feeder that when thus tearing the flesh from a struggling whale it may be approached quite close in a boat and harpooned as though it were drugged.

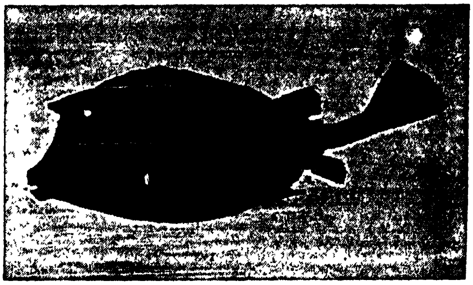
The Blue Shark is a frequent visitor to European waters, though, fortunately, it does not as a rule swim inshore. Small by comparison with the white shark, this one ranges between fifteen and twenty-five feet, and a man would be but part of a meal for it. Our blue shark is smaller.

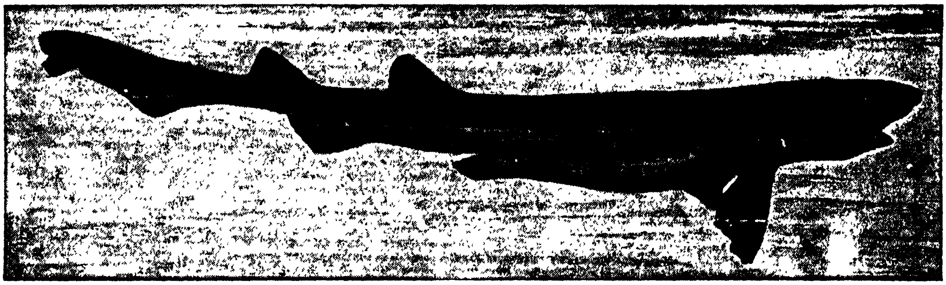
The records of all these sharks are very horrifying. Considering the sea as a jungle, we must regard the sharks as among the beasts of prey, brutes with hyena-like instincts, cowardly, or, let us say, discreet, in that they will not always attack a man who valiantly kicks out at them in the water, but will have him with fatal sureness if he slackens.

They are scavengers. They eat the foulest organic matter cast into the sea; they have been known to swallow bags, cans, sacks of coke. Here is a shark story for you. One in pursuit of a whale's tongue made a mistake in its intended victim. The whale was one of the sperm species. It opened its mouth as wide as a shark could desire, but took the shark in bodily and swallowed it. A little later the whale was caught, and inside the whale was the shark, fifteen feet

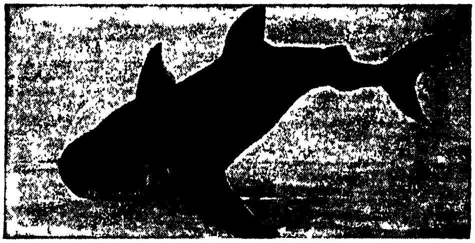
CREATURES OF THE OCEAN DEEPS

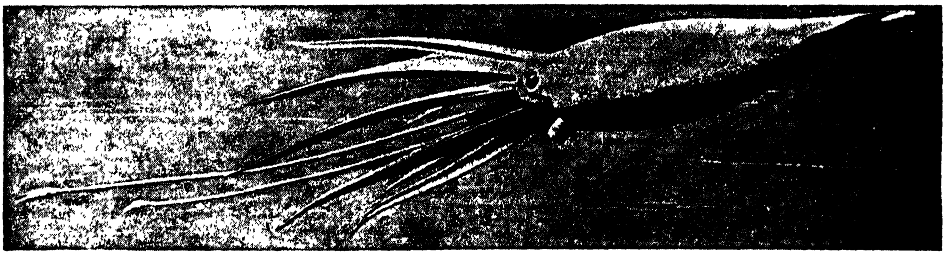

Filefish.

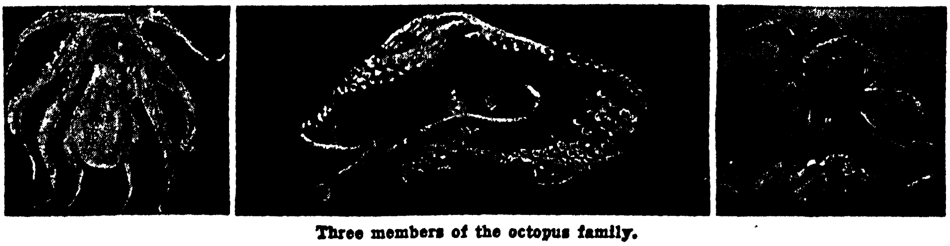

Coffer fish.


Dogfish.

Squid.


Basking shark.


The cuttlefish.


Three members of the octopus family.

in length and as lively and vicious as when at large in the sea. There are many shark stories, and it is hard to know how much to believe.

THE TERRIBLE SAWFISH THAT CAN CUT A MAN IN HALF

After all, a shark gives a clean, terrific bite which is swift death. Next door to the sharks in relationship are the Sawfishes. Here we have huge brutes in which the upper jaw is continued in a long, flattened beak, both edges of which are set with dreadful teeth, about twenty on each edge.

This saw is used by the fish to gash open the soft under parts of a whale or a large fish, and to feed on the product of the attack; or it may kill many small fish in a school. As the giraffe delivers an amazing sidelong blow with his horns, so the sawfish with a corresponding movement of his saw can cut a man in half. We often see these implements of sawfishes in museums and antiquarian shops.

THE FIERCE GIANT WHICH DRAGGED A YACHT FROM ITS ANCHORS

In 1923 a party in Panama Bay had an adventure with sawfishes which would have sent the old-time seamen frantic with superstitious alarm. One sawfish which was taken on a baited fourteen-pound steel hook bolted with it like a harpooned whale. It dragged a fishing boat at a great pace for a quarter of a mile. In so doing it approached the steam yacht owned by one of the party. The owner cast a rope on to the vessel, where the rope was attached to a capstan to prevent the sawfish from pulling away. But the fish was by no means mastered. It hauled at the rope, dragged the yacht from its anchors, and towed it hither and thither for three hours. Eventually it was conquered, drawn inshore and landed. It proved to be twenty-nine feet long, nineteen feet round and weighed two and a quarter tons.

Later a female sawfish was caught in the same waters, thirty-one feet long, twenty-one feet round and weighing 5,700 pounds. Fish with saws six feet long and a foot broad at the base are not uncommon in the tropics. In the other amazing hauls from those same tropical waters came a shark weighing 1,760 pounds, with jaws in which two men were able to stand upright back to back, and a hammerhead weighing three-quarters of a ton.

Similarity of sound may cause confusion between the sawfish and the Swordfish, though the two genera are far apart in the scheme of classification. The swordfish is, in name at any rate, sometimes found in our nurseries: since his scientific title is one of the few beginning with *X*, he is often in the alphabet books of rhymes where *X* stands for *Xiphias*.

THE FURIOUS FISH THAT WILL TILT AT A SHIP WITH ITS SWORD

The Xiphias is most common in the warmer waters of the Atlantic and the Pacific, but comes as far north as the Grand Bank, and many are taken off the New England coast. It is common in the Mediterranean, and is occasionally seen off Ireland.

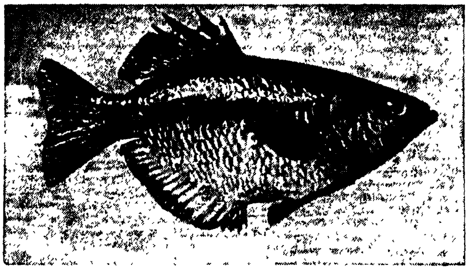
The bodily length of the adult fish may be some fifteen feet, and the sword, which is a sort of very dense bone spear, is upward of a yard long. In practice the swordfish's methods are quite unlike the stealthy approach of the sawfish. Here it is an appalling charge like a rhinoceros at a thorn bush. A tornado of furiously darting bone and muscle is behind the blow of the sword, which is driven right through an inoffensive human bather or deep into the vitals of a whale or lesser creature.

Fear is an emotion unknown to a swordfish, and he tilts at a ship with as much ferocity as at a man. Many a tough little craft in the old days of unsheathed wood came never again to port from far journeys to the tropics, and a swordfish may have known why, for these savage brutes will charge a ship, perhaps by mistake for a whale.

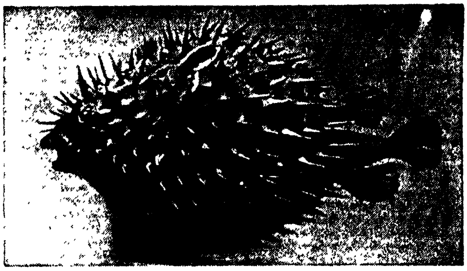
One may see in a London museum evidence of their strength. There is the broken sword of a fish which drove its implement through the hull and thirteen inches of solid timber of a ship which was sailing between Bombay and Calcutta. A second trophy is a broken sword which went through twenty-two inches of ship's timber.

These deadly living swords were five inches and more in circumference. Had they not snapped off and remained in the openings which they caused, those two ships would have been added to the long roll of tragedies unexplained at sea. Swordfish are excellent food, though they are not found in every market. They are caught by means of a harpoon, and their capture is exciting, for they struggle

NATURE'S CHILDREN OF THE SEA



Archer Fish.

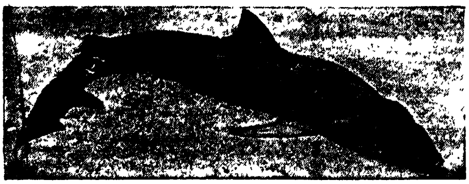


Lesser Spotted Globefish.

The Fox Shark, or Thresher.

Japanese Sawfish.

Hammer-headed Shark.



The Tope.

Porbeagle Shark.

The pictures on these pages are reproduced by courtesy of Messrs. Berridge, Warne and others.

vigorously to free themselves. It requires a quick eye and a steady hand to strike them as they dash through the water.

CREATURES WITH MANY LIMBS AND A BEAK LIKE A PARROT'S

Next in this unpleasant gallery we must rank sea creatures which are not fishes but a lower Order, the *Cephalopods,* in which occur the octopus, cuttlefish and the squids. Carrying eight arms, every inch of them studded with sucker disks, the Octopus devotes all its ingenuity and strength to clutching a victim, man or fish, and drawing him or it with irresistible force to a cruel mouth like the horny beak of a huge parrot. The rest is a rending and ripping, piecemeal. The lesser sorts are to be found in coastal waters; but though their clinging tenacity may so seriously impede a swimmer's actions as to cause him to drown, they are not often to be feared.

In the deep sea, however, they are an abiding terror to bathers and are the creatures the diver fears most. His only chance of escape is to cut the enemy's arms away from him one by one. Often that is impossible, and it frequently happens that man and octopus are drawn together to the deck, the brute writhing and gripping till it is hacked in fragments from the terrified diver.

THE FEARFUL THING THAT HAPPENS WHEN A SQUID MEETS A WHALE

The Giant Squids are creatures of the wide ocean, and could hardly find a living in less spacious surroundings. Here are nightmares in real life, with bodies weighing perhaps half a ton. They have ten arms, two of which are longer than the others. The largest which have been found off Newfoundland weigh perhaps a thousand pounds and are forty feet or more over all. The longer arms are thirty feet or more in length and are armed with disks as big as saucers, each disk carrying a ring of horny hooks like the claws of tigers. The talons hook and hold, the disks cling by suction, and the victim is drawn irresistibly to that awful central beak.

What forms their food we do not know. When seen, they are commonly in conflict with a great sperm whale, their arms writhing like ship masts, clutching, gripping, tearing at the whale, while the whale placidly eats its living bonds.

It is from the contents of the stomachs of whales which have been caught that we obtain our knowledge of these great squids. The body of one was said to match a ship's barrel which held 350 gallons; pieces of its tentacles were found to be eight feet long and eight feet high. What a picture of immensity these figures suggest—and what a swallow for a whale!

HOW AN ENEMY FROM THE SEA FURNISHED A COLOR

All the cephalopods have the habit of swimming backward. They propel themselves by squirting water in a forward direction, so producing a rearward motion of their bodies. The retreat is aided by the discharge of a fluid which darkens the water and renders them invisible. This fluid is the sepia which was the first of pigments used by the ancients other than that obtained from vegetable substances. The chalky shell-like internal framework of the Cuttlefish is also put to good purpose. As cuttlefish bone it is often placed in bird cages. Ground fine, it is "pounce," which was used to powder the parchment on which lawyers wrote their deeds. As with the smaller species of octopus, the smaller squids are not dangerous, as they are timid and not very strong.

Having now glanced at the giants and ogres which are sometimes found on the surface, let us spend a moment in the deeps. Their range begins beyond the sunlight, which penetrates faintly in clear water to a depth of 1,200 feet. Deeper than that the fishes are what we call abyssal types. The temperature of the depths is near the freezing-point of fresh water, often below; and in any place it changes little, and there is little or no current.

It would seem that all the fish here are developments of types which swim in more ordinary conditions. They are not unique in themselves, but unique only in the life which they lead and in the manner in which their equipment and habits fit their dismal circumstances. We do not know as much about them as we desire to know, from the fact that no implement has yet been devised which can bring up great fish, which we are sure must be there, from the deeps of the sea.

Small things can be captured in ingeniously contrived trawls, but not monsters, if monsters exist. The greatest depth at which fish have been taken is just under 18,000 feet, in the western Atlantic, but there are places in the sea more than 31,000 feet deep, and probably life is there, if we could reach and capture it intact.

One difficulty in bringing such life to the surface is that fish hauled from the abysses are accustomed to sustain enormous pressure from the water overlying them. That pressure amounts to four and a half pounds to the square inch for every ten feet we descend; but, as the fish's body is charged with fluid, the pressure is from within as well as from without, rendering life possible. Remove the external pressure, however, and the effect is disastrous: the fish bursts.

Still, venturesome students have made their hauls, and we know that the deep seas have life in its most astonishing forms. In some cases the eyes are enormously developed; in others there are no eyes at all. Some have phosphorescent lamps which they light, lamps like electric bulbs at the head, lamps like glow-worms scattered along the sides of the body.

Many have huge teeth, and some even are able to eat prey larger than themselves. Some of the eyeless fish have power to light the waters. The presumption is that the light is not for themselves but to lure other fishes, and that the lamp-bearers have a highly organized sense of smell or touch so that they are able to take advantage of the near approach of inquisitive visitors to snap them up. The species of creatures in the abysses are many in number, and some are among the most hideous and formidably armed creatures known to science.

Many of these fish are black inside and out. Others are transparent, while still others are gorgeously colored. Blues, oranges, reds, greens, violets and purples are all there, though there may be no eye to see them, and no light to see them by.

Not all of the fishes shown in the colored plates from pages 5785 to 5788 belong to the deep sea. Some are found in the shallower waters, but the ugly Black Gulper on page 5788 is a resident of the deeps. His enormous jaws are loosely held together, and he often swallows a fish larger than himself. Just above him you see the Red Frogfish with his gaping mouth opening upward and the filament moving to and fro. We must suppose that it is intended to attract the attention of other fish and bring them in reach of the open jaws. Another curious-colored member of the family is shown on page 5785.

THE ELFIN SHARK AND THE FRILLED SHARK

The Oarfish may be as much as twenty feet long. The closely related Unicorn Fish is much smaller. Both are compressed, and the fin extends the whole length of the back. When found near the surface they are nearly always dead or dying. As mentioned above, they explode when the outside pressure is reduced as they come near the surface.

THE SCABBARD FISH WHICH COMES TO THE SHORE

The Scabbard Fish, known to Australians as the Frostfish from its extraordinary habit, of wriggling to shore when frost puts a nip in the water, is really a halfway house of life between the abyss and the shallower seas. Essentially it is a deep-sea creature, but, as we see, it makes its way even to the land. It is occasionally seen in Europe as well as in Australia.

But defense and weapons of aggression are not peculiar to these fish. The Globefishes are as prickly as hedgehogs for defense; they have such formidable beaks that one has been known to eat its way out of the shark which swallowed it, and the Sac-fish branch of the family has the power to inflate a membrane covering its abdomen, turn upside down, and float with such wind or current as cares to propel it. A small and harmless specimen called by this name is sometimes seen in our waters. The *Mola*, or Sunfish, is most peculiar. It seems all head, and as it may be ten feet or more long and weigh well on toward a ton, its appearance is startling. There is a colored picture of it on page 5784.

THE HIGHLY COLORED FISH THAT HAS HORNS LIKE A COW

Nearly allied to these are the *Balistides*, a singular group, the filefish, or trigger fish, and the coffer fish. The last-named fishes are brilliantly colored, their hue being a danger signal. But there is armament of a more material nature about the Coffer Fishes, for they have bony horns which give them the name of Cowfishes.

In another way the Filefishes, often beautifully tinted, are even more interesting. In a way they resemble hyenas and the larger macaws in that they have jaws of incredible strength. They not only bite off knobs of solid coral, but they crack the great shells of the pearl oysters and devour the contents. And thereby hangs a tale of sheer wonder, but we tell it in the story of Molluscs, on page 6883. You will find pictures of many of these strange fishes in the colored section beginning on page 5781.

Having mentioned the filefish, we had better guard ourselves against the danger of confounding this with the Tilefish. This is one with a history serving to remind us that great catastrophes occur in nature as in the midst of life in civilized lands.

They were first discovered in the warm waters off the coast of Massachusetts in 1879. The master of the fishing schooner had never seen them before, nor did the scientists recognize them. They proved to be good eating, however, and there was pleasure at the discovery of a new fish of large size.

In the spring of 1882, however, there came an unwonted succession of great gales. The effect of these was as if they pushed aside the stream of warm water in which the tilefishes lived, and seas of frigid water replaced the warm. The result was amazing. The tilefish caught cold and died. One fisherman reported sailing for 150 miles through water covered with dead and dying fish. It was estimated that not less than 1,400 million tilefish were seen floating dead. There may have been many more.

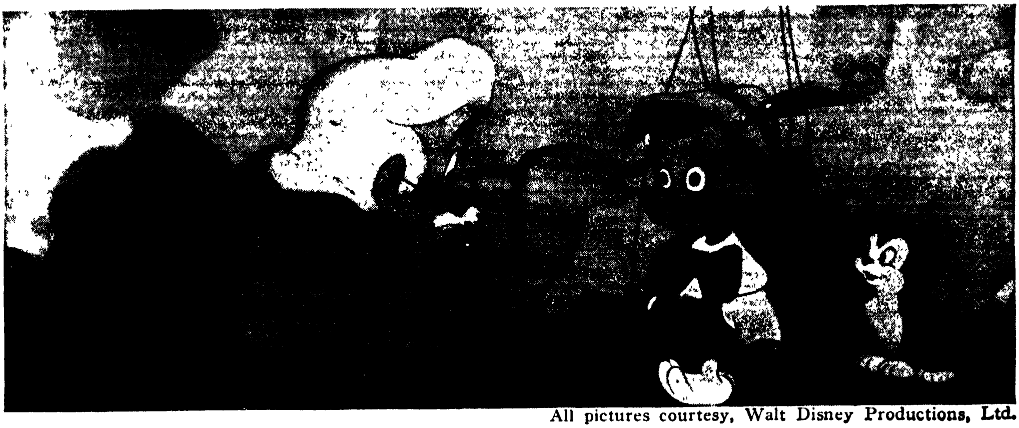
HOW NATURE PROTECTS HER CHILDREN FROM CALAMITY

After the storms died down, fishermen went again to catch tilefish. Not one was found. Years elapsed without anyone's catching a tilefish, and it was feared that the species had died out. In 1892 a few were caught, tilefish returned in small numbers, multiplied, and slowly restocked the scene of that great disaster. How they returned we can only guess. Some few may have fled in fright, while there was yet time, to warmer waters out of reach of the invading currents of cold, and ancestral memory of the old hunting-grounds may eventually have brought them back. Or others, not originally of that area, may gradually have drifted in to feed in the region. Where they were before 1879, or where they went after 1882, no one knows.

But we can see, from this clean-cut example, how local species have died out in the past. It is to guard against such wholesale destruction that Nature charges her children with an energy which makes them disperse themselves as widely as possible, and so lessen the risk of total obliteration.

We leave a thousand aspects of our subject untouched. For truly the sea is inexhaustible, and so is the life within it.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 5949.



All pictures courtesy, Walt Disney Productions, Ltd.

Pinocchio, the puppet who became a boy.

OUR ANIMATED FRIENDS

MICKEY MOUSE and DONALD DUCK

SNOW WHITE, PINOCCHIO and JIMINY CRICKET

WHEN you go to the movies and see an actor jump on his horse and ride off in a cloud of dust, you know that you are looking at the picture of a real, live man, a live horse, and real dust.

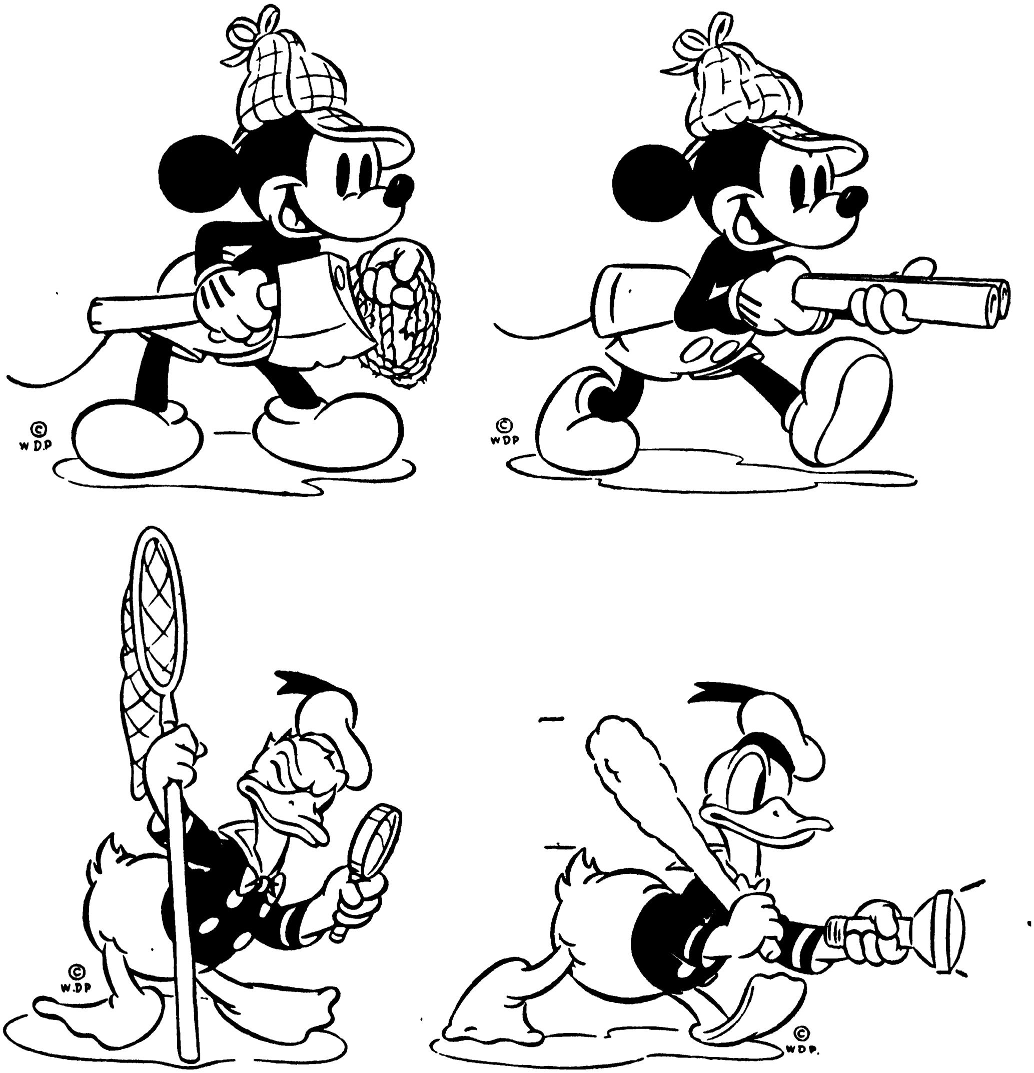
When Mickey Mouse comes on the screen, you know he isn't a mouse at all, but a comical picture drawn with pen and ink. Yet Mickey Mouse moves and talks. Pinocchio and Jiminy Cricket, Dopey and Donald Duck go through exciting adventures on land and sea. How, then, do they move, if they are not real, but only drawings? In order to understand this, we must first understand how real people "move" on the screen.

The hero of the Western play jumps on his horse, and every movement he makes is snapped by the camera. There are many different pictures, taken quickly, one after another. A bit of film is unwound in back of the camera lens. Snap! A picture. That bit of film is wound away from the lens, another bit comes in place. Snap! Another picture. All these pictures are shown to you on the screen in the order in which they are taken. They are reeled off at such speed that we do not see them as a number of different pictures. They seem to us one smoothly moving picture, since the retina of the eye retains the image of each picture after it has disappeared from the screen.

Animated pictures, like those about Mickey Mouse and Donald Duck and Snow White and Pinocchio, are not pictures of people but pictures of drawings. Every movement that you see is a separate drawing. When Snow White clapped her hands, every change of position had to be drawn. No fewer than 250,000 drawings were used for the color picture "Snow White and the Seven Dwarfs." As many as 570 artists worked on the picture for more than two years. It was estimated that if Walt Disney, who created the picture, had wanted to draw every part of it himself, he would have had to work steadily for 230 years.

Let us see what actually happened. Mr. Disney decided to make an animated production in color, from the lovable old nursery tale of Snow White, with certain changes to adapt it to picture presentation. He talked it over with the writers in his studio, and together they wrote the outline of the story as it would appear on the screen. Then they wrote the dialogue, and the music department wrote the songs and other music. The story was then divided up into its various scenes and these were further divided and sketches made, illustrating the story, step by step, of Snow White from the beginning to the end.

The sketches and dialogue were given to the picture directors, who called in the musicians and the length of each scene was decided upon. A number of artists started to work on background scenes, such as the outside and inside of the palace, the forest, the mine where the dwarfs worked, and the little cottage in the wood.



Mickey Mouse and Donald Duck are well known characters all over the world.

Other artists, those who made the picture live, the animators, were then called in. Each animator was given certain scenes, or sequences, to draw. The picture director showed him the sketches, told him what events were to take place in his scene, gave him the dialogue and the music and the sound effects for those scenes.

The animator is a very important artist. He must be able to draw with skill and charm and he must also be something of an actor, since he must imagine the action of the picture before he can draw it. Minnie Mouse's affected mincing way of walking, and Donald Duck's arrogant swagger are really triumphs of imagination. Donald walks like a duck, but he also looks like a very self-satisfied but querulous human.

The animators work on transparent paper placed over a drawing board with a light showing through from beneath. After a drawing is complete, a second sheet of paper is laid on top, and a new drawing made, just a little different, in certain details, to show action. Perhaps an arm is raised, or a foot poised to take a step. On a third sheet of paper the action is carried forward one more bit, and so on until a scene is "acted out."

MILLIONS OF DRAWINGS FOR A FULL LENGTH PICTURE

The chief animators in the studio drew the most important points of the action, in the scenes of Snow White. Each artist had skilled assistants who drew some of the details, and still other workers who filled in, under instruction, the small, finely-graded changes to complete the action. Most of the drawings were reworked three or four times or more, until they were exactly right. At least two million drawings were made, from which 250,000 were chosen, for Snow White and the Seven Dwarfs.

When an animator and his helpers finished a series of drawings, and when they were approved by the directors and finally by the producer, these were taken to the inking and painting department, where girls transferred them to sheets of celluloid and outlined the characters with pen and India ink. Other girls painted them, applying the colors on the reverse side of the celluloid so that the outlines would show through. Correct color application was gained by the use of a master key chart where every color and shade to be used was clearly marked by a letter or number. The purpose of transferring the drawings to celluloid, in making pictures, is to make possible the placing of the celluloid over a scenic background, thus creating the impression of characters acting in a stage setting. As you read above, when the animators started their tasks, the background artists also began their work. Now the two were put together.

MILES OF FILM USED TO PHOTOGRAPH SNOW WHITE

The set-ups, as the celluloids over backgrounds are called, were photographed, a long and careful operation. Many weeks were consumed in photographing Snow White. More than 281 miles of film were used, and 556 miles of animation paper.

After the drawings were photographed, the film was examined and cut just as if it were a picture in a studio where real actors work. You read about the cutting of films in the article Making Moving Pictures, page 6593.

However, it must be remembered that real actors do work also in the studios. Two sets of actors took the parts of Snow White and the dwarfs and the wicked queen and the prince. One set was chosen for their voices. Scores of voices were tried out, before the choices were made. Radio performers often secure positions as "voices." The voices for Donald Duck, Minnie Mouse and other well-known cartoon characters work on yearly contracts. Walt Disney himself is the "voice" of Mickey Mouse. Dialogue, music and other sounds are recorded on sound tracks and timed to correspond with the many yards of film as they are run off.

Drawings are simple, free from fussy detail.

The dialogue for Snow White was all re-

ANIMATOR WITH BACKGROUND DRAWING

Over this background drawing will be placed a drawing on celluloid showing a character in action. The "set-up," as the celluloid over the background drawing is called, will be photographed. Then another celluloid, showing the character in the next stage of the action will be placed over the background, and that set-up will be photographed. Sometimes the background is animated, as this one would be if the arms of the windmill were to be shown in motion.

All photographs, copyright, Walt Disney Productions, Ltd.

Once a queen sat sewing by the palace window. She pricked her finger, so that two drops of blood fell upon the snow on the window sill. "I wish I had a little daughter," sighed the queen, "with cheeks as rosy as these drops of blood, skin as white as snow and hair as black as the window frame." Here we see little Snow White as the animators have drawn her. Pretty as a picture, isn't she? She is just a picture.

corded before an animator made a single drawing. The animator was guided by the voices in this way. A chart was given him, showing the length of each word, the time between words, the accents and other details. If Snow White said "Hello," for instance, and the chart showed that this word, recorded, would occupy eight frames of film, the animator must produce eight drawings, in order, in which Snow White's lips moved to form the word, with whatever gestures or movements, such as a wave of the hand, the director might have indicated. A frame is the name given to each separate picture on a strip of film. Just think how many thousands of drawings must have been made.

The second set of actors served as models for the animators. Models were secured who looked as much as possible as Snow White and the prince and the queen looked in the artists' imagination. They were clothed exactly like the characters in the production and the artists studied how they walked and talked, how the folds of material in their clothing fell as they moved, how their hair moved in the breeze and other actions. The animator had to transfer all these things to his drawing, but in simpler form, keeping the spirit and distinction of each character's actions, but omitting details. The characters themselves could not be drawn with true-to-life proportions. Heads, hands and feet had to be made larger, in order to seem right, in the animations. In other words, the use of the models was purely inspirational.

Some animators have a very interesting special work. They animate things like rain, shadows, sparkles on jewels and boiling water. In Snow White they showed the wind blowing, and the witch's brew in the kettle bubbling, the room spinning, and the apple changing color.

The Story of Snow White, or Snowdrop, as she is sometimes called, is a famous old fairy tale that has been loved by many generations of children. The story of Snowdrop and the Dwarfs is told on page 2454.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 6034.

ANIMATOR AND LAYOUT MAN AT WORK

Preparing a set-up for photographing. An animated picture requires many thousands of photographs.

The layout man corresponds to the scene, or set, designer in a live action studio.

Vergil reading his story of the adventures of Aeneas, legendary founder of Rome, to Augustus Caesar.

LATIN LITERATURE

IN two other chapters of THE BOOK OF KNOWLEDGE we tell you the story of ancient Rome, the center of the greatest empire in antiquity. In this article you will learn about the men of letters who flourished in Rome and in the lands that she conquered. These men wrote in Latin, the language of ancient Rome; therefore, we give the name of Latin literature to their works.

Latin belongs to the Indo-European family of languages; it is quite closely related to Greek. At first it was only one of a number of dialects spoken in the Italian peninsula. In time, however, as the power of Rome extended over Italy, it became the official language of almost the whole peninsula. Still later, its use became widespread in a large part of the civilized world.

We know little about the beginnings of Latin literature, for only a few scraps have come down to us. There are fragments of lullabies sung by mothers to their babes; magic words spoken by shepherds to preserve their flocks; old proverbs handed down from father to son. There are traces also of the strange songs that the priests of the war god Mars chanted. There are public records, too —laws, lists of officials and the like. These fragments give us some idea of the kind of literature that the Romans might have developed if they had not come under the influence of the Greeks.

By the middle of the third century B.C., when the first Latin works of any importance were written, the Greeks had already produced many literary masterpieces—the epic poems of Homer, the histories of Herodotus, Thucydides and Xenophon, the philosophical works of Plato and Aristotle, the tragedies of Aeschylus, Sophocles and Euripides. We tell you about these works in our chapter on Greek Literature.

While Rome was still an insignificant little town on the Tiber River, the Greeks had planted colonies in southern Italy. Many years later Rome established trade relations with these colonies, some of which had become prosperous cities. In this way the Romans came to know something about the Greek language and literature. Still later, the Roman armies overran the Greek cities of southern Italy, and as a result Rome was brought in even closer contact with the civilization of the Greeks.

The Romans—that is, those who could appreciate good literature—looked upon the writings of the Greeks with awe. It was perfectly natural, therefore, that they should use these works as models when they began to write their own plays and poems and histories. Latin literature never freed itself entirely from the Greek influence. Most Roman writers either consciously imitated the masterpieces of the Greeks, or else were powerfully inspired by them.

The first important name in Latin literature was that of a Greek—Livius Andronicus. When the Romans captured the Greek city of Tarentum, in southern Italy, in 272 B.C. a youth called Andronicus was one of the numerous captives. He was brought to Rome, where he was sold as a slave to a nobleman called Marcus Livius Salinator. Andronicus taught Greek and Latin to the children of this rich Roman gentleman.

Terence, the Carthaginian slave who became a famous Roman playwright.

When Andronicus was freed, he took the name of Livius Andronicus, and he continued to teach. There were no Latin works that he could use as textbooks; therefore he made his own textbook by translating Homer's ODYSSEY into Latin. Andronicus also translated Greek tragedies and comedies into Latin and he composed hymns for public occasions. Only a few fragments of his works survive. They show that he was not a great writer; but he pointed the way to others.

The next important name is that of Gnaeus Naevius, who wrote in the last half of the third century B.C. He was a veteran of the first Punic War, in which Rome fought against the North African city of Carthage. Naevius became a writer at Rome after the war. He composed many tragedies and comedies. Some were adapted from the Greek; in others he gave dramatic form to Roman legends.

Naevius also wrote the first Latin epic—THE PUNIC WAR. The first part of this poem deals with the early history of Rome. We find here the legendary story of Aeneas, a Trojan hero, who fled to Italy after his native city was destroyed by the Greeks. The descendants of Aeneas were supposed to have founded Rome. Vergil's AENEID, the greatest epic in Latin literature, owes much to THE PUNIC WAR of Naevius.

Quintus Ennius (239-169 B.C.) surpassed Naevius as an epic poet. Like Naevius he was a veteran who came to Rome to seek his fortune as a man of letters. He was one of the most industrious of writers; his works include translations from the Greek, epigrams, satires and Roman historical dramas. The greatest of his works is his ANNALS, an epic poem based on the history of Rome from the earliest days to the poet's own times.

About six hundred lines of the ANNALS remain—enough to show us that Ennius was a remarkably gifted writer. The Romans thought highly of this poet, who breathed the spirit of pride in Rome's great men and their brave deeds. They often quoted Ennius' famous line—*Moribus antiquis res stat Romana virisque:* "The Roman state stands firm upon its base of ancient customs and men molded in the ancient pattern."

Next we come to the two foremost writers of comedies in Latin literature—Plautus and Terence. Their works were based on the comedies of a number of Greek writers— including Menander and Philemon—who flourished at Athens about the end of the fourth century B.C. It is a curious fact that only fragments of these Greek comedies have survived, so we know of them chiefly through the imitations of Plautus and Terence.

Titus Maccius Plautus (died 184 B.C.) was a native of the province of Umbria He came to Rome and worked as a stage hand. He made money, lost it and had to hire out to a miller. While in the miller's service he began to write plays, and he became very successful. He continued to write for the stage until the year of his death.

Plautus was the author of more than a hundred comedies, of which twenty have come down to us. The scene of most of the plays is laid in Athens. They generally tell of the love of a wellborn young man for a girl of lowly station. The young man, who faces the opposition of his father, is helped by his slave or by a hanger-on, called a parasite. In the end the two young lovers are united; generally it turns out that the girl is really of good family and that she had been lost or kidnaped while still a child. A few of the plays deal with other subjects. THE CAPTIVES, for example, tells of the friendship between a master and his slave; the AULULARIA, or POT OF GOLD, gives a wonderful portrait of an old miser who loses a pot of gold that he had buried in the ground.

Although all the plays of Plautus follow the Greek pattern of comedies, they show his own particular genius. He was a very talented writer. His characters are real, his dialog is lively and he uses the language of everday life. His humor is hearty; sometimes it becomes quite vulgar. This was also true of the Greek comedies.

The chief rival of Plautus as a writer of comedies was Terence—Publius Terentius Afer (died about 159 B.C.). He was not a Roman, but a native of Carthage. He was brought to Rome as a slave and became the property of a Roman senator, Terentius Lucanus. This good man gave his young slave a fine education, then set him free and introduced him into the best Roman society.

The Carthaginian lad took the name of Terentius (Terence) from that of his benefactor. He devoted himself to literature and produced six comedies, all of which have been preserved. The names of these plays are THE GIRL FROM ANDROS, THE MOTHER-IN-LAW, THE SELF-TORMENTOR, THE EUNUCH, PHORMIO and BROTHERS.

The plays of Terence, like so many plays of Plautus, deal with the love of a wealthy young man for a poor girl, who turns out to be the long-lost daughter of a prominent man. However, Terence's plays differ in many ways from those of Plautus. Plautus wrote for the mass of the people—rude, unlettered and fond of coarse jokes. Terence, however, was influenced by the well-educated Romans of the upper classes who were his friends. Hence, the language of Terence is more refined than that of Plautus and his humor is more gentle.

Terence's comedies still have their admirers. Certain phrases in these fine plays are quoted again and again. There is the famous ***Homo sum; humani nihil a me alienum puto:*** "I am a man; I consider nothing human beneath my notice." There is the equally well-known *Quot homines, tot sententiae:* "There are as many opinions as there are people in this world."

Roman prose began with the legal and official records of the early days of the Republic. As time went on, there was also a considerable amount of historical writing. Much of this was not in Latin, but in Greek, for learned Romans thought that their own language was far too rude to be used in composing historical works. The most distinguished historian of the third century B.C., Quintus Fabius Pictor, wrote in Greek; many others followed his lead.

The first important prose writer in Latin was Marcius Porcius Cato (234-149 B.C.),

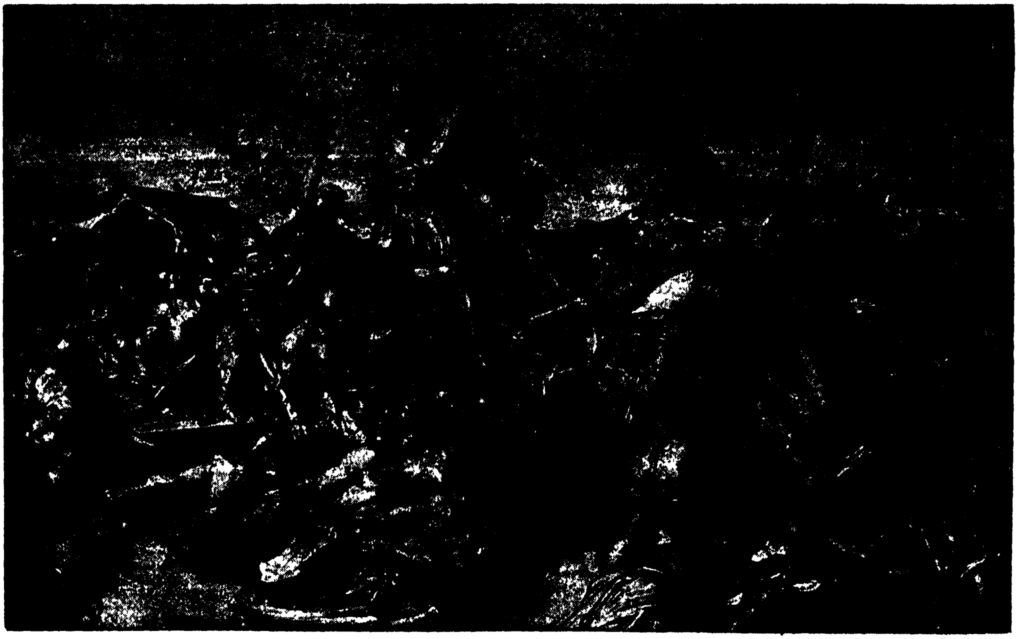


Photo by Riechgitz

Julius Caesar's first invasion of Britain. Caesar's accounts of his military campaigns are still read.

one of the foremost statesmen of Rome. (See Famous Men of Ancient Rome—I.) He wrote many books, but unfortunately only one has come down to us—a treatise called ON AGRICULTURE. In this he tells farmers what to plant, how to till the ground, how to harvest the crops, how to treat slaves and so on.

Cato writes simply and clearly; he often crams a good deal of meaning in a few words. Here are some typical phrases: "Do not buy what you want, but what you must have; what you do not want is dear, even if you pay only a single penny for it." "It is better to wear away than to rust away." "Stick to your subject matter, and the words will come by themselves."

Latin literature is rich in brilliant satires —poems which attack the follies and evil doings of mankind. The first important Roman writer of satires was Gaius Lucilius (died 103 B.C.). He was born in Campania, but lived much of his life in Rome. He took an active part in the social life of the city.

THE BRILLIANT SATIRES THAT ATTACKED THE EVILS OF ROMAN LIFE

In his SATIRES Lucilius writes of the things he sees about him. He tells about himself and about his friends; he violently attacks many Romans for their stupid or wicked way of life. Lucilius was an original poet, but a careless one. It was said of him that he was like a river which carries along precious gold dust mixed with a great deal of rubbish.

The first century before Christ was one of the most fateful in the history of Rome. It was then that the Republic fell and Rome came under the rule of an emperor who had absolute power. It was a century of bloodshed and confusion, of ceaseless foreign and civil wars. Yet Roman literature flourished during this period.

Greek influence made itself felt as strongly as ever in poetry and the drama and in historical writing. It was strong, too, in the field of thought—the search for truth to which we give the name philosophy. The Greek philosopher Epicurus inspired one of the greatest of Latin poems—OF THE NATURE OF THINGS, by Carus Titus Lucretius.

We know almost nothing about Lucretius, except that he lived in the first half of the first century B.C. and that he died in 53. His poem shows, however, that he had made a deep study of the works of Epicurus. This philosopher taught that all things in this world—the sun, the stars, the earth, the living creatures that dwell upon the earth—are made up of tiny particles called atoms. Epicurus, though not the first man to bring forward this idea of atoms, built upon it a philosophy of life which we know today as Epicureanism. "Since we are only a collection of atoms," said Epicurus, "let us devote our little lives to making things as pleasant for ourselves as possible. Yet let us remember that the virtuous life is sure to be the most pleasant."

Lucretius gave poetical expression to these ideas in ON THE NATURE OF THINGS. This is the first long Latin poem that has come down to us. In it Lucretius tells us of the theory of atoms; the origin of life; the world and the movements of the heavenly bodies; the rise and progress of human society; the development of the arts and sciences. The poem is in six parts, called books.

Lucretius is a true poet. We find in his work magnificent passages which rank with the greatest poetry ever written. The most famous of these passages is the one which opens the second book:

Pleasing it is, when the sea is stirred by the raging winds,
To stand upon the shore and watch a wave-tossed wretch;
Not that we take delight in seeing another's pangs,
But that we ourselves are free of the suffering we behold.
It is pleasing, too, when we gaze from afar
Upon two mighty armies clashing upon a plain.
But there's no joy like this, to stand upon the heights,
Which only those who seek true wisdom can attain,
And from there to look down upon the mass of men,
Wandering here and there in the labyrinth of Earth
Seeking all in vain the broad highway of life.

An outstanding lyric poet of this period was Gaius Valerius Catullus (died about 54 B.C.). Catullus, born in Verona, came to Rome while a boy. Wealthy, handsome, witty, he became a favorite of the gay society of the capital. He tried his hand at poetry as a boy and he continued to write verses to the end of his days.

Much of his poetry was inspired by his love for a Roman lady whose real name was Clodia, but whom he called Lesbia in his verses. Some of his poems to Lesbia reveal the joys and sorrows of love. Others are written in a playful mood. Such is the charming poem in which Catullus laments the death of Lesbia's pet sparrow:

The bird that was her joy and pride,
And never, never, left her side.

Not all of his poems deal with love. In some of his verses Catullus praises his friends and heaps the most violent abuse upon his enemies. In other poems he discusses the tangled political situation of the day. In verses that he wrote on his return to his country home at Sirmio, he displays a deep love of nature. Perhaps the most touching of all his poems is one that he wrote after visiting the grave of his dearly loved brother. It contains the immortal phrase *Ave atque vale:* "Hale and farewell."

And now we come to Marcus Tullius Cicero (106-43 B.C.), one of the great masters of Latin prose. We give an account of his life in the article Famous Men of Ancient Rome—II. Cicero was one of the leading statesmen of Rome; he was equally famed as a man of letters.

Cicero was an orator who could stir people with his eloquence and wit.

He was one of the finest orators who ever lived. Fifty-seven of his orations have come down to us. Among these are (1) the seven speeches against Verres, a corrupt governor who had plundered and tortured the Sicilians; (2) the four speeches against Catiline, who had planned to overthrow the Roman Republic; (3) the fourteen speeches against Mark Antony, a political rival of Cicero. The orations against Antony are called THE PHILIPPICS, because they make us think of the orations against King Philip of Macedonia by Demosthenes, the great Athenian orator.

Cicero's speeches are marvelously varied. There are passages in which he sets forth his arguments with the greatest clearness; others in which he attacks his opponents with savage irony; still others in which he makes a most stirring appeal to the feelings of his listeners.

The opening lines of his first oration against Catiline will give you some idea of Cicero's eloquence. These lines consist of a violent attack on Catiline, who had appeared in the Roman Senate after his conspiracy had been revealed. "How much longer, O Catiline," cries Cicero, "will you abuse our patience? How much longer will your mad passion mock us? What limit will there ever be to your impudence? Are you not moved by the night guard on the Palatine Hill, by the watchfulness of the city, by the terror of the people?...O, what a time! What a state of affairs! The Senate knows of this man's deeds; the consul sees them; yet this creature still lives!"

Cicero was a lifelong student of Greek philosophy. His writings in the field of philosophy were generally in the form of dialogs, or conversations. These works include THE BOUNDARIES OF GOOD AND EVIL, THE TUSCULAN DISPUTATIONS, ON THE NATURE OF THE GODS, CATO THE ELDER, LAELIUS. Cicero was not an original thinker, but he excelled in presenting the thoughts of others in clear and lively fashion.

Perhaps the most interesting of Cicero's writings are his letters, which cover the period from 68 B.C. to 43 B.C., the year of his death. In these letters Cicero shares his most intimate thoughts with his friends. He gives interesting glimpses of the outstanding Romans of the day—Caesar, Pompey, Crassus, Mark Antony. He sheds light on political happenings. We also find learned remarks on literature and history and casual business notes. Truly there is a little of everything in this correspondence.

Another noted Roman statesman who was also a man of letters was Gaius Julius Caesar, who became the dictator of Rome in 45 B.C. and was assassinated in the following year. (See Famous Men of Rome—II.) Caesar wrote a good deal but the only works of his that have come down to us are his Commentaries on the Gallic War and his Commentaries on the Civil War. All boys and girls who study Latin are familiar with Caesar's Gallic War, in which he tells about his campaigns against the warlike inhabitants of Gaul (modern France). The other work deals with Caesar's fight with Pompey for the mastery of Rome.

Gaius Sallustius Crispus (86-35 B.C.), who is known as Sallust, also wrote about stirring events in Roman history. Only his Conspiracy of Catiline and his War Against Jugurtha have been preserved. Sallust writes interestingly but he is too prejudiced to be a reliable historian. There is a strong moral note in his works, which contain many bitter attacks on the corrupt politicians of Rome. Yet this stern foe of corruption made a fortune when he was governor of Numidia by mercilessly plundering that province!

THE AGE OF AUGUSTUS BRINGS A NEW ERA IN ROMAN LITERATURE

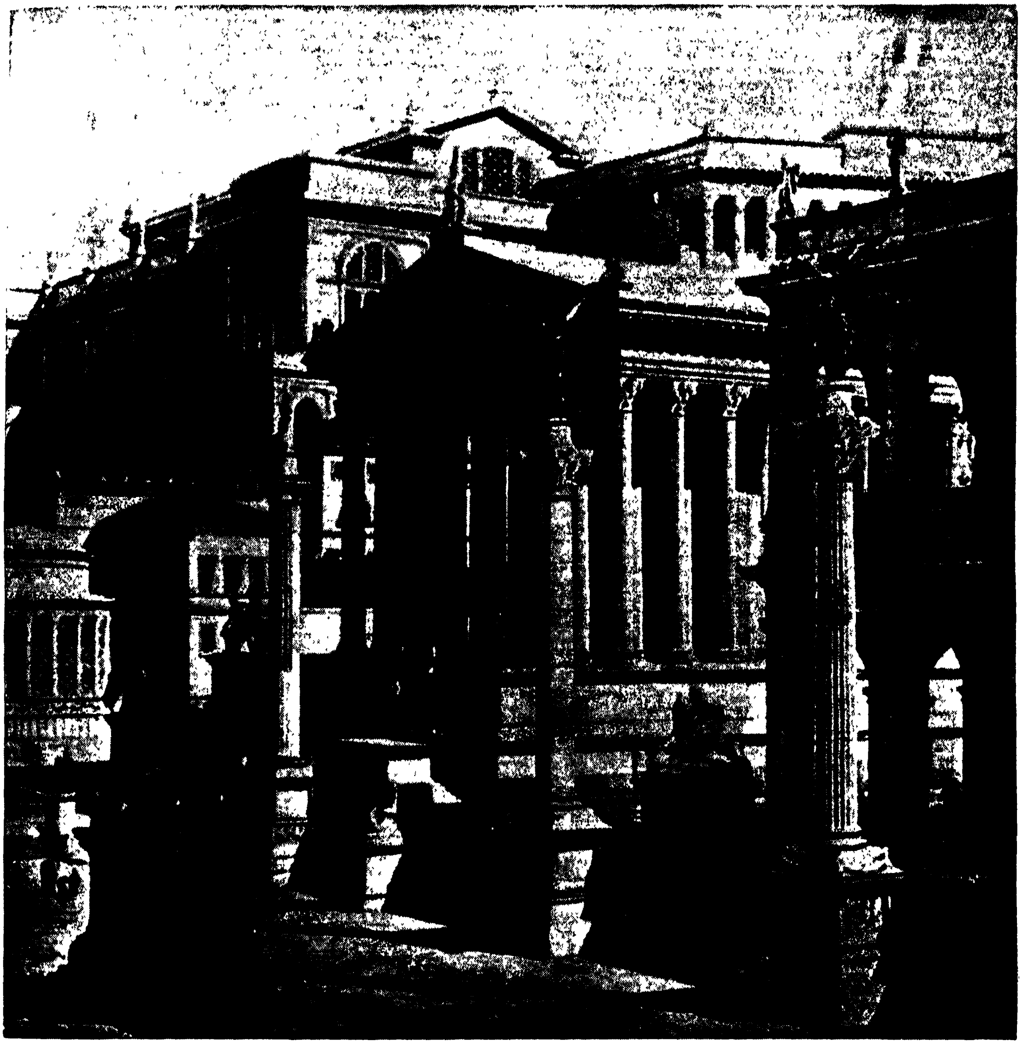
When the Roman Republic came to an end in 27 B.C. a new era dawned. From now on the master of Rome was the emperor, who was an absolute monarch. This meant that men of letters could no longer write freely about their own times, for they had to be careful not to offend the emperor. If they displeased the master, they were liable to be imprisoned or exiled or put to death.

Fortunately some of the emperors encouraged literature and the fine arts. Among the most enlightened of all was Augustus, the first emperor. (See Famous Men of Ancient Rome—II.) He gave all possible aid to men of letters, and his example was followed by many of his friends. In this favorable atmosphere literature flourished. As a result the Augustan Age—the period when Augustus ruled—became the Golden Age of Latin literature.

The Roman Forum in the days of the Empire. In the of Vesta, where the vestal virgins guarded the sacred

The most famous poet of the Augustan Age was Publius Vergilius Maro, better known to English-speaking people as Vergil, or Virgil. He was born near Mantua in 70 B.C., and received a very fine education. He established himself at Rome, where his poems soon found warm admirers. One of these admirers was Maecenas, the foremost patron of letters of the day. Vergil became a favorite of the emperor Augustus, who presented him with a magnificent estate near Naples. The poet died at Brundisium (modern Brindisi) in 19 B.C.

Vergil wrote three long poems: The Eclogues, The Georgics and The Aeneid.



background is the palace of the Caesars, on the Palatine hill. The little round building in the center is the temple flame. The temple of Julius Caesar is at the left, and at the right is the temple of Castor and Pollux.

In The Eclogues (poems in which shepherds converse with one another) Vergil imitates the Greek poet Theocritus, who lived in the third century B.C. The Eclogues are made up of ten comparatively short poems, which give us charming, if not very realistic, pictures of shepherd life. Some of these poems contain hidden references to the poet and to his friends. The fourth eclogue, addressed to the consul Pollio and written in 40 B.C., was destined to become the most famous of all. It tells of the birth of a child who is to bring about an era of good will among men. In the Middle Ages this poem was supposed to predict the coming of Christ.

The Georgics, in four books, is a poem on agriculture. (The name comes from two Greek words meaning "tilling of the soil.") The work is based to a certain extent on Works and Days, a poem by the Greek Hesiod, who lived in the sixth century B.C. Vergil's work is far superior to Hesiod's. He has adapted the material freely and has added many original touches; his poetry has a charming grace that is lacking in the stiff verses of Hesiod. In The Georgics Vergil discusses the tilling of the soil, the tasks to be performed in the various seasons, the growing of trees and vines and the care of horses, cattle and bees.

Vergil's most renowned work is the epic poem known as THE AENEID. He began this poem in 29 B.C., at the request of Augustus, and he worked on it for ten years. He intended to devote three more years to a final revision, but his death prevented him from carrying out this plan. It is said that on his deathbed he begged his friends to destroy the manuscript of his poem, because he felt that it was too imperfect. Fortunately, they did not carry out his request.

THE AENEID is divided into twelve parts, called cantos. It tells the story of Aeneas, the Trojan hero whose descendants were supposed to have founded Rome. The hero's native city of Troy is destroyed by the Greeks, but he manages to escape with a band of followers. After many adventures, they arrive at Carthage, a North African town ruled over by a beautiful queen, Dido. Dido receives the Trojans kindly and listens eagerly as Aeneas tells of the capture of Troy and his flight from that city.

Sallust wrote about stirring events in Roman history. His writing is interesting, but it is not always fair to all sides.

The beautiful Dido falls in love with the Trojan hero, who returns her love. She wants him to marry her and to reign with her over both the Carthaginians and the Trojans. But it is the destiny of Aeneas to go on to Italy, where his descendants are to found the mighty Roman nation. The god Mercury comes to him and reminds him of his destiny. And so he leaves Dido, who in despair kills herself.

Aeneas and his men cross the Mediterranean Sea and land at Cumae, in Italy. With a prophetess, called a sibyl, as his guide, Aeneas now goes down to the underworld in order to consult with the spirit of his father, Anchises. Anchises tells his son of the glories of Rome in the centuries to come. This gives the poet a chance to praise the great Romans of all the ages, including his master, Augustus.

The last six cantos deal mainly with the fighting between the Trojans and certain native Italian peoples, who rise against the invaders of their land. The poem ends with a long-drawn-out duel between Aeneas and Turnus, his chief foe. Turnus is slain and the triumph of Aeneas is assured.

Vergil owes much to the older Roman poets, Naevius and Ennius, who had already dealt with the legend of Aeneas. He has also borrowed freely from THE ILIAD and THE ODYSSEY of Homer. The wanderings of Aeneas in the first six cantos recall the wanderings of Odysseus, or Ulysses, in THE ODYSSEY; the battles of the last six cantos have their counterpart in the numberless battles of THE ILIAD. Vergil follows Homer in his use of gods as all-important characters in the tale. Some of his finest figures of speech, too, are imitated or adapted from Homer. Critics have traced the defects of THE AENEID to Vergil's close imitation of the Greek poet. For one thing, the gods play so important a part that Aeneas and the rest often seem to be puppets rather than flesh-and-blood creatures. The battle scenes in THE ILIAD are apt to bore modern readers; those in THE AENEID are certainly not more interesting. As one French critic puts it, "One wearies of these eternal combats, as much alike as two peas in a pod."

Yet undoubtedly there is much to admire in THE AENEID. It is a truly national epic; rarely has any poet paid such a magnificent tribute to his native land. The poem abounds, too, in passages of great poetic beauty. The destruction of Troy, the death of Dido, the descent to the underworld—each of these episodes represents epic-writing at its best. In THE AENEID we find also a genuine feeling for nature—the sea trembling under the light of the moon, the Tiber rolling on to the sea, the gloomy stillness of the forest.

Vergil was held to be the greatest of Latin poets by the Romans of his own generation and those that followed. He continued to be admired throughout the Middle Ages. The poet, Dante, praised Vergil in these verses:

You are my master and my model, too;
From your immortal verses did I draw
That lofty style for which men honor me.

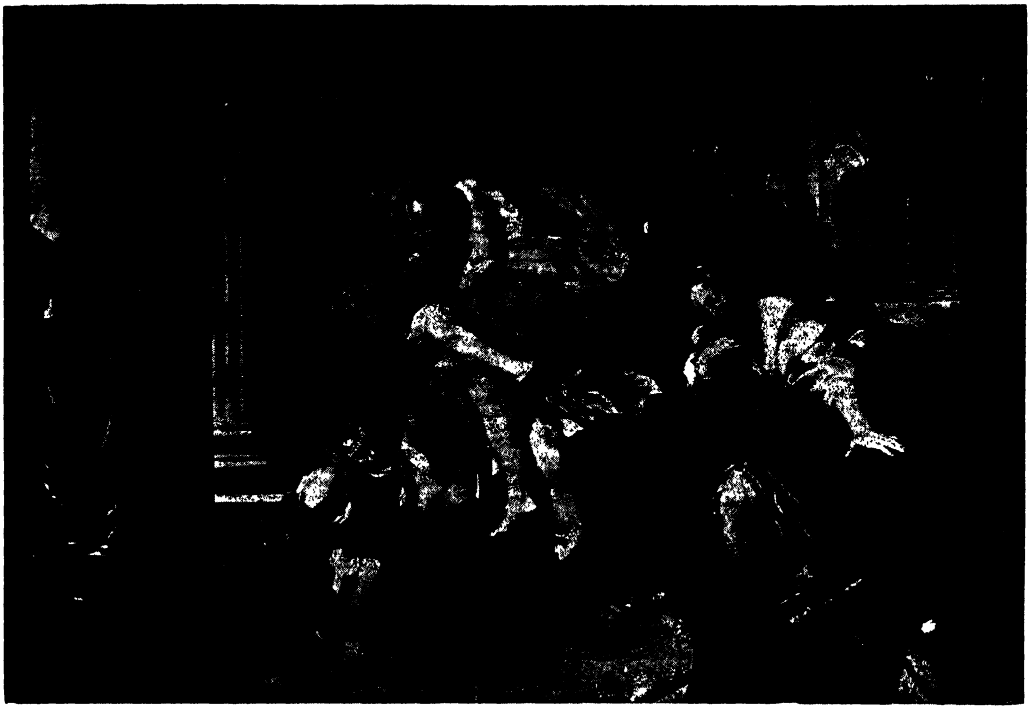


Photo by Anderson, Rome

In this scene from Vergil's Aeneid, the hero, Aeneas, escapes from the burning city of Troy and its Greek conquerors, carrying his aged father, Anchises, with him. This was the beginning of many wanderings and adventures.

In Dante's magnificent epic poem, THE DIVINE COMEDY, it is Vergil who serves as the poet's guide in his wanderings in Hell. (See our chapter on Italian literature.) In later ages, too, Vergil continued to inspire the poets of western Europe. The two chief epics of the Renaissance—the JERUSALEM LOST of the Italian Tasso and the LUSIAD of the Portuguese Camoëns—owe much to THE AENEID.

Vergil's friend, Horace (Quintus Horatius Flaccus) was also a poet of the very first rank. Horace was born in 65 B.C. His father was a former slave who had won his freedom and who earned a comfortable living as an auctioneer's clerk. This devoted father gave Horace the best education that Rome could afford; later the lad was sent to Athens to study philosophy.

Horace lost all his property in the civil wars, and, as he says in one of his poems, poverty forced him to write verses. He attracted the attention of Maecenas, who became his friend and patron. Maecenas gave Horace a country estate in the Sabine hills, and the poet immortalized this "Sabine farm" in his poems. Honored by his many friends and by the emperor Augustus himself, Horace lived a happy life. He died in 8 B.C. His principal poetical works are his SATIRES, EPODES, EPISTLES and ODES. His SATIRES owe much to Lucilius; however, Horace is a kindlier critic than Lucilius and his verses are far more polished. THE SATIRES take up many different themes: the discontent of each man with his lot; the account of a voyage to Brundisium; the joys of the farmer's life; the poet's unhappy meeting with a bore. Horace himself called his SATIRES *sermones,* or talks. They are, indeed, the talks of a wise and witty man, who gives us his ideas (and very sensible ones they are, too) on all sorts of topics.

An epode is a poem with alternating long and short lines. Horace's EPODES follow this poetical pattern; otherwise they do not differ greatly from THE SATIRES. The most amusing of the epodes is the second. In this poem the banker Alfius tells of the joys of life in the country; yes, the country is the place for him! He gives up all his business affairs on the fifteenth of the month; after two short weeks he is back in harness.

The poems called EPISTLES are in the form of letters. The most famous is one addressed to the Pisos—father and sons. It is a sort of informal treatise on poetry, and therefore it has become known as THE POETIC ART. It is full of shrewd advice, set forth in striking language. In the Renaissance it was a textbook of the Italians and Frenchmen and Spaniards who were trying to make over their own literatures.

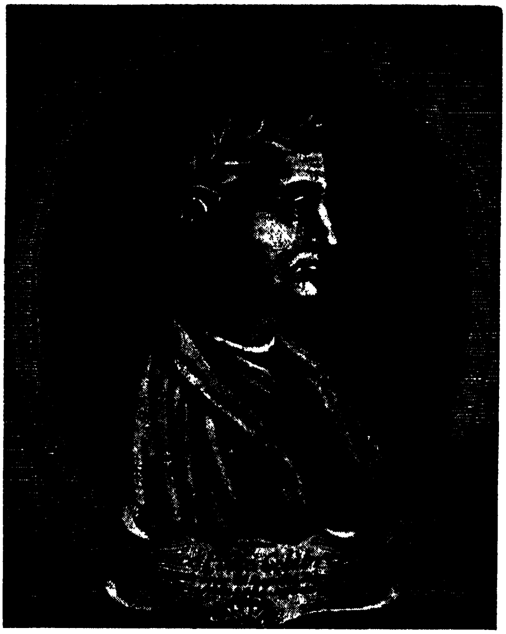
Horace's finest poems, perhaps, are contained in the collection known as THE ODES. Here he follows in the footsteps of the Greek lyric poets—Alcaeus, Sappho and Anacreon, among others; in fact, some of THE ODES are free translation of their poems. Yet, if Horace has drawn THE ODES from a wide variety of sources, he has welded them into a perfect artistic whole. The poet was proud of these poems; he called them a "monument more lasting than bronze."

THE ODES deal with almost everything under the sun—love, death, good wine, the perils of the sea, life in the country, the poet's narrow escape from death, the praise of the emperor Augustus. Horace, who loved to retire to his country estate after the confusion of Rome, had a keen eye for nature. Here is his description of a winter's day in the country:

You see that Mount Soracte gleams,
  Buried deep in dazzling snow;
While all the ice-choked streams are still,
  And all the burdened trees bow low.
Then, piling logs upon the fire,
  We make the roaring flames leap high,
And, drinking deep of Sabine wine,
  We watch the hours flit swiftly by.

One of the most charming of THE ODES contains this little dialog between two lovers:

HE: "While I was pleasing in your sight,
  Nor had a rival for your love,
I was as happy as a king;
  I swear it by the gods above!"
SHE: "While to your Lydia you were true,
  And shunned the artful Chloe's wiles,
All those who saw me deemed me blest,
  As they beheld my radiant smiles."
HE: "Chloe's now the girl for me;
  She sings as sweetly as a dove.
For her I'd not regret to die,
  If fate would spare my own true love!"
SHE: "Calais is now the boy for me,
  As fair as any god above.
Yes, twice for him I'd gladly die,
  If fate would spare my own true love!"
HE: "What if our old love now should cast
  Its chains about us two once more?
What if, with Chloe cast aside,
  You'd open wide for me your door?"
SHE: "Though he is fair as any god,
  And you have ever made me sigh,
Deceitful youth! and wrathful, too!
  With you I'd gladly live and die."



Horace, most lovable of all the Roman poets.

Another product of the Augustan Age was the poet Ovid (Publius Ovidius Naso; 43 B.C.—18 A.D.). He lived a rather scandalous life and at last he was exiled by Augustus to a town on the shores of the Black Sea. He was the author of a great number of love poems, of which the most famous are two long ones called THE ART OF LOVE and THE CURES FOR LOVE. He also wrote a work called FESTIVALS, a poetical account of the Roman holidays—their beginnings and the ceremonies connected with them.

His masterpiece is the long poem known as THE METAMORPHOSES (changes). This work deals with the changes of form that both gods and men undergo in the old pagan myths. In one of these, for example, Jupiter, the father of the gods, becomes a bull; in another, a swan; in still another, a shower of gold. There are few myths in which some change of this sort does not take place. Hence, the "poem of changes" is really a vast collection of Greek and Roman myths.

In THE METAMORPHOSES Ovid arranges the myths in the form of a connected narrative, which begins with the story of creation. The poet takes the tale down to his own day; he tells us how Julius Caesar joined the immortal family of the gods, and he predicts that Augustus, the grandnephew of Caesar, will have the same happy destiny.

The verses of The Metamorphoses have a smooth and easy grace that is more to the liking of many modern readers than the sculptured beauty of The Aeneid. Ovid is a skillful story-teller; some of the episodes of The Metamorphoses are models of narrative poetry. Such is the story of Phaëthon, the son of the sun-god Apollo, who met his death while trying to drive his father's chariot. Such is the story of King Midas, who turned everything he touched into gold. We tell you the story of Midas on page 3443.

The poet Tibullus (died about 19 B.C.) was the author of several books of elegies. Nowadays an elegy is a poem of lamentation for the dead. When Tibullus wrote, however, an elegy was a lyric poem written in a certain kind of metre, called elegiac metre. It was generally a lament, not for the dead, but for love that was not repaid. Tibullus was a sensitive soul, and his poems are full of a gentle melancholy. The great love of his life was for a woman whom he has immortalized in his verses as Delia. Another outstanding writer of elegies was Propertius (died about 15 B.C.), who sang the praises of his fair Cynthia.

Seneca, teacher and philosopher.

The great prose writer of the Augustan Age was Livy (Titus Livius; 59 B.C.–17 A.D.). Livy was a firm believer in the republican form of government, but he accepted the rule of Augustus and became a friend of the Emperor. He was the author of a vast work called The History of Rome from the Founding of the City. This history covers the long period from the founding of Rome to the death of the dictator Sulla in 78 B.C. It was originally in 145 books, of which 35 have been preserved.

Livy took his material from earlier historians; when they disagreed, he chose the account that seemed most probable. He made no effort to go to the original sources—official records, inscriptions, old monuments. He never visited the scenes of battles in order to see how accurate the older historians were in their description of hills and valleys and rivers. Some modern historians are apt to scoff at this way of writing history.

Yet, in spite of all, Livy is a great historian. He gives a picture of events that is, on the whole, true, even if he is sometimes inaccurate in details. Furthermore, he does not think of history as a meaningless succession of battles and intrigues; for him it forms a definite pattern—a linked chain of events. Livy is interested not only in what men do, but also in what makes them act as they do. Besides, he is a literary artist of great skill. He won widespread fame in his own day. It is said that a Spaniard traveled all the way from Cadiz to Rome merely to see the great Livy. He then returned at once to Cadiz without casting a single glance at the palaces and temples of the great city by the yellow waters of the Tiber.

The Golden Age of Roman literature came to an end with the death of Augustus in 14 A.D. The following period, from 14 A.D. to 117 A.D. (the date of the death of the emperor Trajan) is known as the Silver Age. On the whole it was a period of decline; yet there were some first-rate writers.

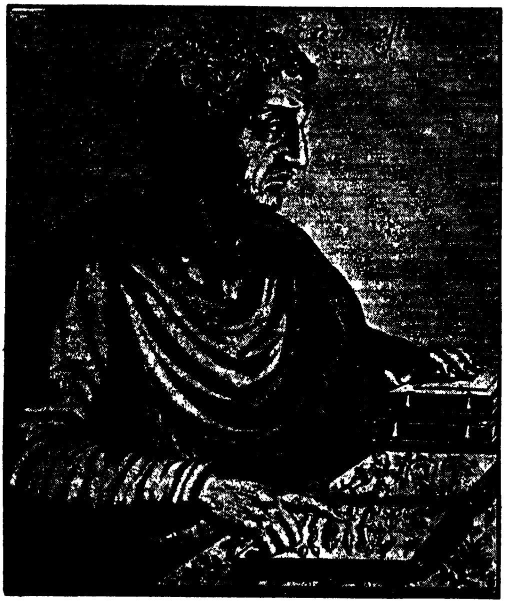
One of the most interesting of these was Lucius Annaeus Seneca (died 65 A.D.). Seneca, a Stoic philosopher, was the tutor of Nero, who later became emperor. In the early years of Nero's reign Seneca and his friend Burrhus were the real masters of Rome. Later, Seneca lost his influence at court. In 65 A.D. he was accused of having joined a conspiracy against the Emperor, and he was forced to take his own life.

Seneca was one of the most fertile of the ancient writers and a number of his works have come down to us. These include nine tragedies based on Greek mythology. They were admired in the period of the Renaissance; but to most modern readers they seem to be wordy and tearful imitations of the far greater tragedies of the Greeks. Seneca also wrote a striking satire on the emperor Claudius, The Apocolocyntosis, or How a Pumpkin Becomes a God.

His most renowned works are his writings on philosophical subjects, particularly his Moral Epistles and his Studies of Nature. In these he sets forth the doctrines of Stoicism; he also discusses many practical problems. Seneca is really a preacher with a wholesome message to mankind—a preacher who did not always follow his own teachings.

His influence was great in the ages that followed.

His nephew Lucan (Marcus Annaeus Lucanus, 39-65 A.D.) was a poet of great renown in his own day. Like Seneca, Lucan was accused of having taken part in the conspiracy of 65 A.D., and he was forced to kill himself. The only work of his that has come down to us is an epic poem in ten books called THE PHARSALIA. In this work he tells of the strife between Julius Caesar and Pompey. THE PHARSALIA makes good reading. It would have been better if the poet had not loaded it down with references to old myths.



Pliny the Elder, who studied and wrote about nature, is always entertaining, though not always accurate.

Another uncle and nephew who won literary fame in the Silver Age were the elder and the younger Pliny. Gaius Plinius Secundus (23-79 A.D.), called Pliny the Elder, was a public official whose spare time was spent in an eager search after knowledge. He was the commander of a fleet stationed at Misenum when Mount Vesuvius erupted in 79 A.D. and buried Pompeii and Herculaneum under mountains of lava and ashes. Pliny tried to examine the eruption at close range and lost his life in the attempt.

His endless studies bore fruit in a monumental work in thirty-seven books, called THE NATURAL HISTORY. In this Pliny describes the whole world of nature: the heavens, the earth, animals, plants, minerals. THE NATURAL HISTORY is a most curious combination of wisdom and folly. Some of the material in the work is based on the author's own observation and this is generally accurate and often valuable.

But sometimes Pliny sought knowledge of nature not in nature itself but in books. He was too apt to accept the wildest tales of earlier writers. We find in THE NATURAL HISTORY, for example, the story of the phoenix, that fabulous bird which burns itself after living for 500 years and then rises anew from its ashes. We also find the ridiculous story of the basilisk, a monster that was thought to kill a man with a glance. THE NATURAL HISTORY was accepted as gospel truth for hundreds of years.

Pliny the Younger (Gaius Plinius Caecilius Secundus; died about 114 A.D.) was a public official, like his uncle. He is chiefly famed for his EPISTLES, which include seventy-two letters to the emperor Trajan. The letters throw a good deal of light on the customs and the family life of the times. They also show that the author was a vain man, though generous.

The poet Martial (Marcus Valerius Martialis; died 104 A.D.) wrote fourteen books of epigrams. Epigrams are short pieces dealing concisely with a single thought or event. Those of Martial are generally marked by sparkling wit. Here are two interesting examples:

You honor, Vacerra, the ancients alone,
And never praise poets unless dead and gone;

A thousand pardons, friend, if rude I seem,
But it's not worth dying to gain your esteem!

With all your heart embrace your lot;
Wish not for death, and fear it not.

An epitaph is a short poem or prose writing in memory of one who has died; it is often carved on a tomb. Martial wrote one of the most touching epitaphs in all literature for a little girl who had died at the age of six. It contains these beautiful lines:

Rest lightly on her, Earth;
Lightly she rested on thee!

Another poet of the Silver Age was Juvenal (Decimus Junius Juvenalis; died about 135 A.D.), who attacked the vices of Rome in his SATIRES. He tells of the swollen pride and the gluttony of the upper classes, the crimes of women, the bad example that parents set for their children. He gives us an unforgettable picture of Rome—the streets laden with filth; the falling tiles that endanger the passer-by; the drunken rioters; the gangs of robbers.

Juvenal is one of the most widely read of Latin poets. Modern readers are fascinated by his savage eloquence and the vividness of his descriptions. He has the art of creating pointed phrases which will never die: *Mens sana in corpore sano:* "A healthy mind in a healthy body." *Rara avis:* "A rare bird." *Quis custodet ipsos custodes?:* "Who will guard the guardians?" *Pan et circenses:* "Bread and circuses" (that was all that the lower classes of Rome craved, according to the poet).

Boethius wrote about philosophy while in prison under sentence of death.

We come next to the historian, Cornelius Tacitus (died about 117 A.D.). He was a high official under a number of emperors, and he writes not only as a learned student of history, but as a practical man of affairs. Tacitus was the author of a famous little treatise called Germany; it gives us the earliest detailed account that we have of the Germans who dwelt in the north of Europe and who were destined to overthrow the Empire. He also wrote a biography of Agricola, his father-in-law, a famous general who completed the conquest of Britian.

His greatest works are his Histories, dealing with events that happened in his own lifetime, and his Annals, taking up the early years of the Empire. A considerable part of these works has been lost; but enough remains to show that Tacitus was a historian of the highest rank.

He sets before us in dark colors the corruption, intrigues and murders in the capital city in the reigns of the bad emperors of the first century A.D. The style of Tacitus is concise and to the point; he delights in striking phrases like these: "Traitors are hated even by those to whom they show favor." "When the state was most corrupt, laws were most numerous." "Wrong a man and you will hate him." Sometimes he reaches great heights of eloquence. Such is the bitter passage in which he chides the gods for permitting so much wickedness in Rome.

Following the Silver Age, Latin literature entered upon a long period of decline. Some of the Church Fathers who wrote during this period—particularly Lactantius, Ambrose, Jerome and Augustine—were masters of Latin prose. Most of their writings, however, belong rather to the history of religion than to that of literature. Of the other writers who flourished after the Silver Age, only one—Boethius—ranks with the great men of Latin literature.

By the time that the Western Roman Empire fell in 476 A.D., Latin literature had almost run its course. Its last worthy representative was Anicius Manlius Severinus Boethius (died 524), a Roman of noble rank. He occupied various offices of state under Theodoric the Great, king of the Ostrogoths, who became the ruler of Italy in 493. Boethius finally fell out of favor with Theodoric. He was accused of conspiring against his royal master and he was put to death.

Boethius is best known for a work called On the Consolation of Philosophy. He wrote it in prison while awaiting his condemnation. The Consolation, which is a rather odd mixture of prose and poetry, begins with the lamentations of Boethius over the sadness of his fate. Suddenly Philosophy appears to him in the form of a beautiful woman. There follows a long dialog, in which Philosophy persuades her follower, Boethius, that good or bad fortune is of no importance. What happens to any one person, she says, represents only a thread in a vast tapestry designed by the Creator. The Consolation was a great favorite throughout the Middle Ages.

With Boethius the history of Latin literature comes to an end. To be sure, Latin continued to be the official language of the Church and of diplomacy. It was used by the educated men of western Europe in the Middle Ages and in the Renaissance. In these periods many poets and historians and philosophers wrote their works in Latin, and they numbered some outstanding men. But their writings are the product of a different kind of civilization from that of ancient Rome. Some of these writings belong to Medieval Latin literature; others, to the Renaissance.

Latin literature, then, really ceased to be a living thing in the sixth century. Yet its influence has continued throughout the ages. Even today the great works of the Roman writers—the poems of Lucretius, Vergil and Horace, the histories of Livy and Tacitus, the philosophical works of Cicero and Boethius—entertain and inspire men of many different lands.

THE NEXT STORY OF LITERATURE IS ON PAGE 6149.

PRONUNCIATION OF LATIN AND GREEK NAMES USED IN THIS ARTICLE

(When *y*, in the words in parentheses, comes before a vowel, it is pronounced like the *y* in "you." *Ay* is pronounced like *ay* in "day." In other cases *y* is pronounced like *y* in "my.")

Aeneid (ee-nee′-id)
Aeneas (ee-nee′-ass)
Aeschylus (ess′-kih-luss)
Alcaeus (al-see′-uss)
Alfius (al′-fih-uss)
Ambrose (am′-brohz)
Anacreon (a-nak′-ree-on)
Anchises (an-ky′-seez)
Andronicus (an-droh-ny′-kuss)
Andros (an′-dross)
Antony (an′-toh-nih)
Apocolocyntosis (a-poh-coh-loh-sin′-toh-siss)
Apollo (a-pol′-oh)
Aristotle (ar′-iss-tot-’l)
Augustine (aw′-guss-teen)
Augustus (aw-guss′-tuss)
Aulularia (aw-loo-lay′-rih-ah)
Boethius (boh-ee′-thih-uss)
Brundisium (broon-dis′-ih-um)
Caesar (see′-zer)
Calais (cah-lah′-iss)
Campania (cam-pan′-yah)
Carthage (car′-thij)
Catiline (cat′-ih-lyn)
Cato (cay′-toh)
Catullus (ca-tul′-uss)
Chloe (cloh′-ee)
Cicero (siss′-eh-roh)
Clodia (cloh′-dih-ah)
Crassus (crass′-uss)
Cumae (kyoo′-mee)
Demosthenes (dee-moss′-theh-neez)
Dido (dy′-doh)
Eclogue (ec′-log)
Ennius (en′-ih-uss)
Epicurus (ep-ih-kyoo′-russ)
Epode (ep′-ohd)
Euripides (yoo-rip′-ih-deez)
Fabius (fay′-bih-uss)
Gallic (gal′-ik)
Georgics (jor′-jiks)
Herculaneum (her-kyoo-lay′-nee-um)
Herodotus (hee-rod′-oh-tuss)
Hesiod (hee′-sih-od)
Homer (hohm′-er)
Horace (hor′-iss)
Iliad (il′-ih-add)
Jerome (jeh-rohm′)
Jugurtha (joo-gur′-thah)
Jupiter (joo′-pih-ter)
Juvenal (joo′-veh-nal)
Lactantius (lac-tan′-shuss)
Laelius (ly′-lih-uss)
Lesbia (lez′-bih-ah)
Livius (liv′-ih-uss)
Livy (liv′-ee)
Lucan (lyoo′-can)
Lucilius (lyoo-sil′-ih-uss)
Lucretius (lyoo-cree′-shih-uss)
Lydia (lid′-ih-ah)
Macedonia (mass-ee-doh′-nih-ah)
Maecenas (meh-see′-nass)
Mantua (man′-tyoo-ah)
Mars (mahrz)
Martial (mar′-shal)
Menander (meh-nan′-der)
Mercury (mer′-kyoo-rih)
Metamorphoses (met-ah-mor′-foh-seez)
Midas (my′-dass)
Misenum (my-see′-num)
Naevius (nee′-vih-uss)
Nero (nee′-roh)
Numidia (nyoo-mid′-ih-ah)
Odyssey (od′-ih-see)
Ovid (ov′-id)
Phaëthon (fay′-eh-thon)
Pharsalia (far-say′-lih-ah)
Philemon (fih-lee′-mon)
Philippics (fih-lip′-iks)
Phoenician (fee-nish′-an)
Phormio (for′-mih-oh)
Pictor (pic′-tor)
Plato (play′-toh)
Plautus (plaw′-tuss)
Pliny (plin′-ih)
Pollio (pawl′-ih-oh)
Pompeii (pom-pay′-yee)
Pompey (pom′-pih)
Propertius (proh-per′-shih-uss)
Punic (pyoo′-nic)
Sabine (say′-byn)
Salinator (sa-lih-nay′-tor)
Sallust (sal′-ust)
Sappho (saf′-oh)
Seneca (sen′-eh-cah)
Sirmio (sir′-mee-oh)
Sophocles (sof′-oh-cleez)
Soracte (soh-rac′-tee)
Sulla (sul′-ah)
Tacitus (tass′-ih-tuss)
Tarentum (tah-ren′-tum)
Terence (ter′-enss)
Theocritus (theh-oc′-rih-tuss)
Theodoric (theh-od′-oh-ric)
Thucydides (thyoo-sid′-ih-deez)
Tiber (ty′-ber)
Tiberius (ty-beer′-ih-uss)
Tibullus (tih-bul′-us)
Trajan (tray′-jan)
Turnus (tur′-nuss)
Tusculan (tuss′-cyoo-lan)
Vacerra (vah-ser′-ah)
Vergil (ver′-jil)
Verona (veh-roh′-nah)
Verres (ver′-eez)
Xenophon (zen′-oh-fon)

FIRE-ENGINE TOMMY

By Margaret Lima Norgaard

Now you shall hear the story of a little boy whose real name was Tommy but whom everyone called "Fire-Engine Tommy." Here is the way he got that name.

Tommy loved fire engines. Every time the siren blew, he ran outside the house to watch the engines go roaring past. And this happened often, for Tommy lived near the engine house—you went down his street to the corner and then turned up another street and went over two crossings, and there was the brick building where the big red fire engines were kept.

When anyone asked Tommy what he was going to be when he grew up, he always said, "I'm going to be a fire chief and ride on the fire engines every day!"

Now, one day Tommy was playing in his yard when all of a sudden he smelled smoke. He looked up at the house next door, and there he saw a curl of blue smoke coming out from under a window. Even while he looked at it, the little blue curl grew wider and bigger.

Tommy dropped his sand-pail and his shovel, and ran across the yard calling: "Mrs. Curtis! Mrs. Curtis! Your house is on fire!"

Nobody answered. Tommy ran to the back door and pounded on it. "Mrs. Curtis!" he cried. "Mrs. Curtis! Fire!" But Mrs. Curtis did not come to the door. Nobody came to the door. There was no one at home.

Tommy ran to the side of the house again and there he saw

that the smoke was coming out heavier and heavier, and little red flames were beginning to lick at the window sill. Then he heard a sound. It was so faint that at first he could not be sure he heard it. It sounded like: "Miau! Miau!" Tommy ran all around the house, looking, because he thought he knew who was making that sound. And, yes, he was right; there, standing up behind the dining-room window, trying to claw her way out, right through the window glass, was Mrs. Curtis' pet kitten, Trixie. Her little red mouth was open as though she were calling to him: "Miau! Save me! Get me out!"

Then Tommy knew what he must do. As fast as his legs could carry him, he ran to the fire box on the corner. But when he tried to ring the alarm, he found that not even by standing on tip-toe could he reach the red box. So he kept on running. He ran down the street and over two crossings and came at last to the fire-engine house. There he found the firemen sitting around a table playing checkers.

"Come quick!" Tommy cried. "Mrs. Curtis' house is on fire!"

But the men only looked at him, and one of them said, "Oh, that's Tommy. I know him. He likes to see the fire engines go by. I don't believe there is any fire."

"There is, there is!" Tommy cried, jumping up and down in his excitement. "And Mrs. Curtis' kitten, Trixie, is inside the house and she can't get out. She'll be burned if you don't hurry."

The fire chief jumped to his feet. "I believe him," he cried. "Come on, men!"

Then all the firemen jumped up and ran around getting ready. They put on their rubber coats and their boots and helmets, and they started up the big engine. They were driving out the door when the fire chief looked down and saw Tommy.

"Come ride up here with me, Tommy," he said.

The driver stopped, and Tommy jumped up beside the fire chief, and the engine roared out the door with Tommy holding tight to the iron bar that ran just underneath the big bell.

Down the street they went a-whizzing. Clang, clang! The people along the way shouted "Fire, fire!" and ran after the engines. Clang-clang! "Fire, fire!"

Some of Tommy's playmates were playing in a yard, and when they ran out to see the engines go by, they saw Tommy. "Why, there's Tommy riding on the fire engine!" they cried. There were two men talking on the sidewalk, and one of them was Tommy's father. "Why there's my son, Tommy," he exclaimed. "How does he happen to be riding on the fire truck beside the chief?"

When the fire engines got to Mrs. Curtis' house, the smoke was coming from every window. The firemen jumped down and began to uncoil the big hose. But Tommy pulled at the fire chief's arm. "Get Trixie out before you put on water," he begged, "or she's sure to get hurt."

So the fire chief broke in the window with his hatchet, and he reached in and pulled out the kitten and gave her to Tommy. The poor little thing was trembling with fright, and Tommy held her tenderly in his arms, smoothing her fur to quiet her. Then he went to watch the firemen attach the hose to the hydrant. Soon streams of water were falling on the fire.

"Here, Tommy," called the chief. "You stand by the hose, just behind this fireman, and you can help hold it. Tommy put the kitten on his shoulder where she held on tightly, and he took hold of the hose with both hands, helping the firemen.

Soon the fire was out, and the firemen went back to their station-house. They had no sooner left than Mrs. Curtis came running up the street. "Did anyone get my kitten out?" she cried.

Then the neighbors told her that her kitten was safe, and that only Tommy's quickness and bravery had saved her house, as well, from being burned down.

That night, after Tommy had gone to bed, he heard a noise downstairs. He was sleepy after his exciting day, but like all little boys he was curious, so he slipped downstairs in his pajamas. There in the hall he saw a red fire truck, half as tall as he, and big enough for him to sit in. It had two long ladders, one on each side, a bell in front, and a real hose wound around a post in the back. Tied to the wheel was a card, and on it he read: "To Fire-Engine Tommy, with thanks from Trixie and Mrs. Curtis."

So that was the way Fire-Engine Tommy got his name.

THE TALE OF PETER RABBIT

By Beatrix Potter

Once upon a time there were four little Rabbits, and their names were—

Flopsy,
Mopsy,
Cotton-tail,
and Peter.

They lived with their Mother in a sand-bank, underneath the root of a very big fir-tree.

"Now, my dears," said old Mrs. Rabbit one morning, "you may go into the fields or down the lane, but don't go into Mr. McGregor's garden: your Father had an accident there; he was put in a pie by Mrs. McGregor. Now run along, and don't get into mischief. I am going out."

Then old Mrs. Rabbit took a basket and her umbrella, and went through the wood to the baker's. She bought a loaf of brown bread and five currant buns.

Flopsy, Mopsy, and Cotton-tail, who were good little bunnies, went down the lane to gather blackberries; but Peter, who was very naughty, ran straight away to Mr. McGregor's garden, and squeezed under the gate!

First he ate some lettuces and some French beans; and then he ate some radishes; and then, feeling rather sick, he went to look for some parsley. But round the end of a cucumber frame, whom should he meet but Mr. McGregor!

Mr. McGregor was on his hands and knees planting out young cabbages, but he jumped up and ran after Peter, waving a rake and calling out, "Stop thief!"

Peter was most dreadfully frightened; he rushed all over the garden, for he had forgotten the way back to the gate.

He lost one of his shoes among the cabbages, and the other shoe amongst the potatoes.

After losing them, he ran on four legs and went faster, so that I think he might have got away altogether if he had not unfortunately run into a gooseberry net, and got caught by the large buttons on his jacket. It was a blue jacket with brass buttons, quite new.

Peter gave himself up for lost, and shed big tears; but his sobs were overheard by some friendly sparrows, who flew to him in great excitement, and implored him to exert himself.

Mr. McGregor came up with a sieve, which he intended to pop upon the top of Peter; but Peter wriggled out just in time, leaving his jacket behind him, and rushed into the tool-shed, and jumped into a can. It would have been a beautiful thing to hide in, if it had not had so much water in it.

Mr. McGregor was quite sure that Peter was somewhere in the tool-shed, perhaps hidden underneath a flower-pot. He began to turn them over carefully, looking under each.

Presently Peter sneezed — "Kertyschoo!" Mr. McGregor was after him in no time, and tried to put his foot upon Peter, who jumped out of a window, upsetting three plants. The window was too small for Mr. McGregor, and he was tired of running after Peter. He went back to his work.

Peter sat down to rest; he was out of breath and trembling with fright, and he had not the least idea which way to go. Also he was very damp with sitting in that can.

After a time he began to wander about, going lippity—lippity—not very fast, and looking all around.

He found a door in a wall; but it was locked, and there was no room for a fat little rabbit to squeeze underneath.

An old mouse was running in and out over the stone doorstep, carrying peas and beans to her family in the wood. Peter asked her the way to the gate, but she had such a large pea in her mouth that she could not answer. She only shook her head at him. Peter began to cry.

Then he tried to find his way straight across the garden, but he became more and more puzzled. Presently, he came to a pond where Mr. McGregor filled his water-cans. A white cat was staring at some gold-fish; she sat very, very still, but now and then the tip of her tail twitched as if it were alive. Peter thought it best to go away without speaking to her; he had heard about cats from his cousin, little Benjamin Bunny.

He went back towards the tool-shed, but suddenly quite close to him, he heard the noise of a hoe—scr-r-ritch, scratch, scratch, scritch. Peter scuttered underneath the bushes. But presently, as nothing happened, he came out, and climbed upon a wheel-barrow, and peeped over. The first thing he saw was Mr. McGregor hoeing onions. His back was turned towards Peter, and beyond him was the gate!

Peter got down very quietly off the wheelbarrow, and started running as fast as he could go, along a straight walk behind some black-currant bushes.

Mr. McGregor caught sight of him at the corner, but Peter did not care. He slipped underneath the gate, and was safe at last in the wood outside the garden.

Mr. McGregor hung up the little jacket and the shoes for a scare-crow to frighten the blackbirds.

Peter never stopped running or looked behind him till he got home to the big fir-tree.

He was so tired that he flopped down upon the nice soft sand on the floor of the rabbit-hole, and shut his eyes. His mother was busy cooking; she wondered what he had done with his clothes. It was the second little jacket and pair of shoes that Peter had lost in a fortnight!

I am sorry to say that Peter was not very well during the evening.

His mother put him to bed, and made some camomile tea; and she gave a dose of it to Peter!

"One table-spoonful to be taken at bedtime."

But Flopsy, Mopsy, and Cotton-tail had bread and milk and blackberries for supper.

THE NEXT READ ALOUD STORIES ARE ON PAGE 6375.

THE TALE OF PETER RABBIT was first published in 1902 and belongs to a series of nineteen books, all of which are beautifully illustrated by the author, Beatrix Potter.

It is not possible to reproduce the exquisite color illustrations in this work, but the reader should endeavor to get copies of the books which have become world-wide classics. If ever you visit the Lake District in England you will probably be able to see the original paintings.

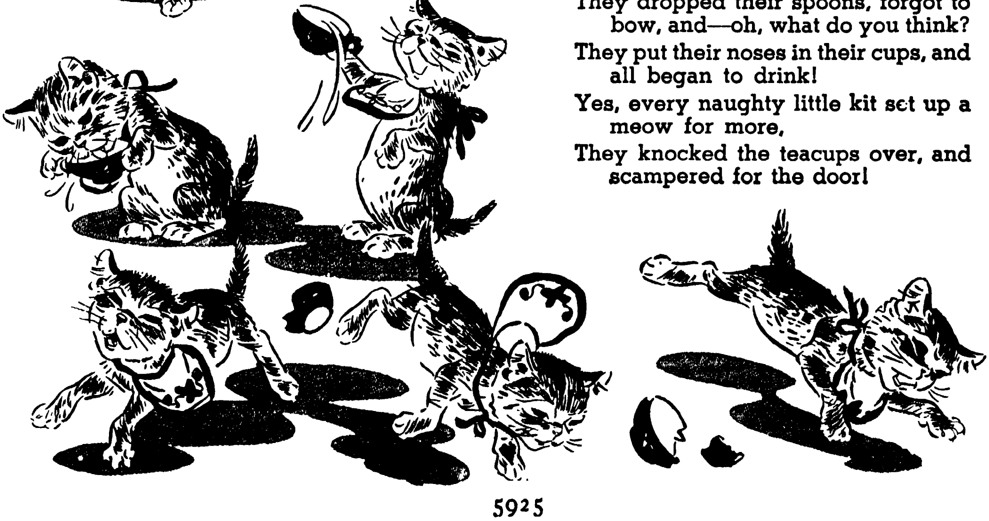
The Tale of Peter Rabbit has been included in The Book of Knowledge by courtesy of the Publishers, Frederick Warne & Co., Ltd., London, England.

Five Little Pussy-Cats

Five little pussy-cats, invited out to tea,
Cried: "Mother, let us go. Oh, do! for good
we'll surely be!
We'll wear our bibs and hold our things as you
have shown us how—
Spoons in right paws, cups in left—and make a
pretty bow;
We'll always say, Yes, if you please, and
Only half of that!"

"Then go, my darling children," said the
happy mother cat.
The five little pussy-cats went out that
night to tea,
Their heads were smooth and glossy,
their tails were swinging free;
They held their things as they had
learned, and tried to be polite—
With snowy bibs beneath their chins
they were a pretty sight.

But, alas for manners beautiful and
coats as soft as silk,
The moment that the little kits were
asked to take some milk
They dropped their spoons, forgot to
bow, and—oh, what do you think?
They put their noses in their cups, and
all began to drink!
Yes, every naughty little kit set up a
meow for more,
They knocked the teacups over, and
scampered for the door!



As I was going to St. Ives,
I met a man with seven wives;
Every wife had seven sacks;
Every sack had seven cats;
Every cat had seven kits;
Kits, cats, sacks, and wives,
How many were there going to St. Ives?

Old Mother Goose, when
She wanted to wander,
Would ride through the air
On a very fine gander.

There was a little girl,
who had a little curl,
Right in the middle of
her forehead;
When she was good, she was
very, very good,
But when she was bad,
she was horrid.

I love little pussy,
Her coat is so warm,
And if I don't hurt her,
She'll do me no harm.

So I'll not pull her tail,
Or drive her away,
But pussy and I
Very gently will play.

She will sit by my side,
And I'll give her her food,
And she'll like me because
I am gentle and good.

Little Bo-peep

Little Bo-peep has lost her sheep,
And doesn't know where to find them;
Let them alone,
and they'll come home,
Bringing their tails
behind them.

Little Bo-peep fell fast asleep,
And dreamt she heard them
bleating;
But when she awoke,
she found it a joke,
For they were still
all fleeting.

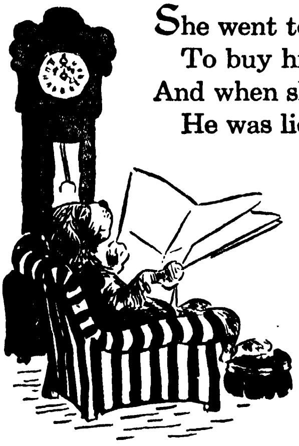
Then up she took her little crook,
Determined for to find them;
She found them indeed,
but it made her heart bleed,
For they'd left their tails
behind them.

It happened one day,
as Bo-peep did stray
Into a meadow hard by,
There she espied
their tails side by side,
All hung on á tree to dry.

Old Mother Hubbard

Old Mother Hubbard
Went to the cupboard
To get her poor dog a bone;
But when she got there
The cupboard was bare,
And so the poor dog had none.

She went to the fishmonger's
To buy him some fish,
And when she came back
He was licking the dish.

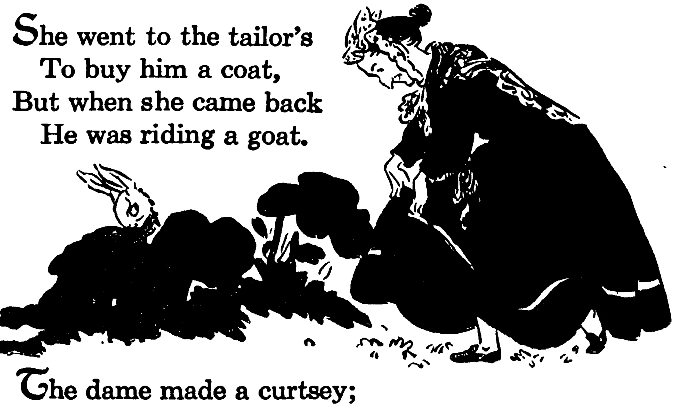


She went to the hatter's
To buy him a hat,
And when she came back
He was feeding the cat.

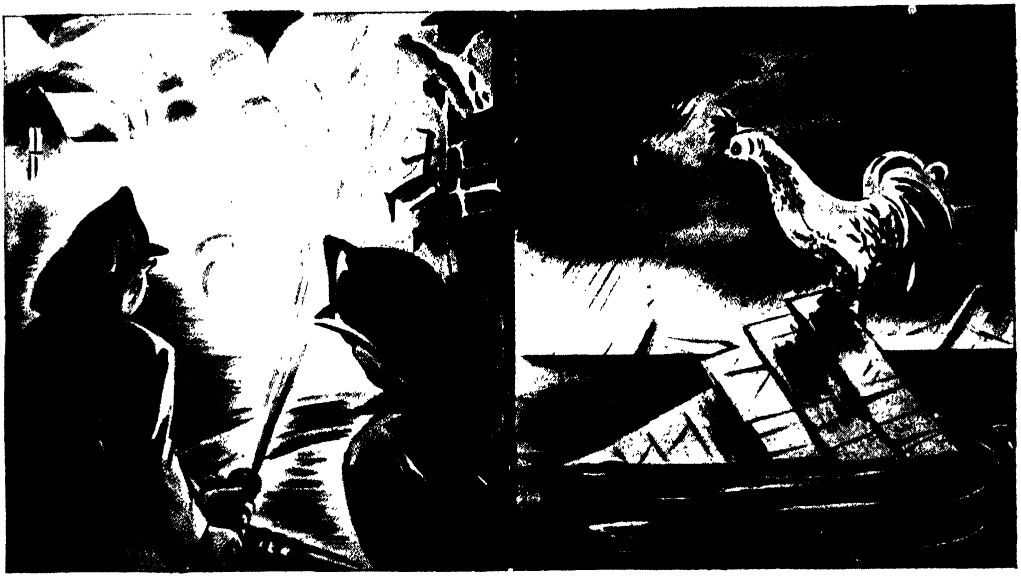
She went to the barber's
To buy him a wig,
But when she came back
He was dancing a jig.

She went to the cobbler's
To buy him some shoes,
But when she came back
He was reading the news.

She went to the tailor's
To buy him a coat,
But when she came back
He was riding a goat.



The dame made a curtsey;
The dog made a bow.
The dame said, "Your servant."
The dog said, "Bow-wow!"



Water to put out a fire has value in use. Water in a flood has no value in use.

VALUE, SUPPLY AND DEMAND

We all have a great many wants, ranging from necessities, such as food, clothing and shelter, to luxuries such as candy, ice cream or fancy fishing tackle. Everyone has an almost unlimited number of wants, and that is a very important fact of life. A second and equally important fact is that these wants can not be satisfied without work. Even though you may not work to earn the money to buy the things you want, your father or some other member of your family must.

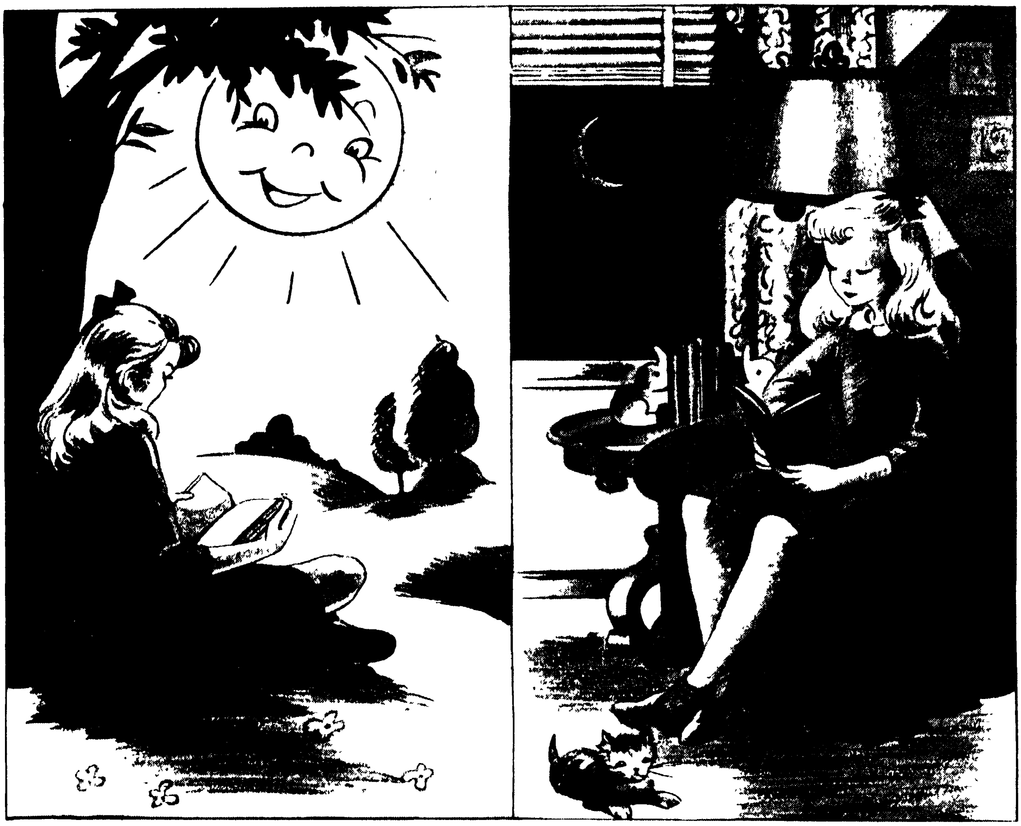
VALUE IN USE

Now, everything we want has value to us. Let us see what is meant by that word, value. Actually it has several different meanings. In everyday conversation the word value is used in a general sense to indicate a strong liking for a thing. We greatly value the spring sunshine or the warm sands of the beach. However, the same thing may be of value to us in one place and worthless in another. For example, the sand at the seashore makes it ideal for play, but it is worse than useless in the desert where the traveler finds too much. A thing may have value at one time and not at another. Fifty years ago buggy whips were in general demand even in large cities, but today there is almost no call for them except in a few farm communities.

Therefore we speak of use value, or value in use. Most things have value in use at some time or place. Water has value in use when we drink it, or when we cook with it, or when we bathe in it, or when, falling as rain on the soil, it gives life to the plants. On the other hand, water in the wrong place is valueless, as when it is leaking through the roof, or if it begins to fall at the wrong time, say, just as the farmer begins to move the newly cut hay from the field to the barn.

ECONOMIC VALUE

When we use the word value in economics, however, it takes on an added meaning. In an economic sense a thing can not have value just because it is useful; it must also be scarce. For example, sunlight is so valuable in use that it is the first necessity of existence, but it is not scarce, and so in economics sunlight and other plentiful things that may be had for the taking are called free goods, since there is more than enough to go around. However, sunlight may not always be free goods.



Such a thing as light may be free goods or economic goods, depending on its usefulness and scarcity. In the picture at the left, sunlight is useful but plentiful. This is a daytime scene in the country, and sunlight is free to all. In the night picture, light is economic goods; it is useful and scarce enough so that we must pay for it.

In a city an apartment on the tenth floor may bring a higher rent than one on the second floor, because the tenth floor gets much more sunlight. In that case, it is economic goods; it is not only useful but also scarce.

EXCHANGE VALUE

There is a third kind of value—exchange value, that is, the quantity of other goods a thing can be exchanged for. A thing which has use value and economic value generally has exchange value also. But not always. A court house, a city park, or a school building, for instance, are not bought and sold by individuals, but they do have use value, and they do have economic value, since they cost money to build, and the materials in them are scarce. However, these exceptions are so few that we usually forget about them. In everyday life when we talk about the value of a thing it is understood that we mean its exchange value.

PRODUCERS AND CONSUMERS GOODS

Business men speak of economic goods as either producers goods or consumers goods. Producers goods are those used in producing other things, as the printing press, the weaving machine, or the ice-cream plant. On the other hand, the books, cloth and ice cream turned out by these machines are called consumers goods because they satisfy our wants directly.

The value of a thing, its economic good, is, as we have said, the quantity of other things which it may be exchanged for; for example, ten marbles may be exchanged for a ball, or one ball for two tops.

The invention and use of money enables us to measure the exchange value of things much more easily. This method of measuring the exchange value of things in terms of money we call price, and so when people talk about value they usually mean price.

Price is the amount of money we give for a thing. Thus it may be said that a large loaf of bread costs twelve cents, a pound of potatoes about three cents and a pound of rice about ten cents. There we see the value of different things measured in one thing — money. This is very convenient, because it gives us a way to judge the relative value of the three things to us. We know that with a quarter we can buy either two loaves of bread at twelve cents, eight pounds of potatoes at three cents, and have a penny left over; or we can buy two and one-half pounds of rice at ten cents—or a loaf of bread, a pound of potatoes and a pound of rice.

So we can make up our minds what to do with the money we have. Price, being exchange value expressed in money, is thus a very good guide.

DEMAND AND SUPPLY

Now let us see what makes things sell for what they do, and why prices or money values rise and fall. We commonly say that prices are set by *demand and supply.* That tells us little or nothing unless we can answer two questions:

1. Why is a person willing to pay a certain price for something he wants?

2. Why must he pay a certain price in order to get the thing wanted?

Only when these questions have been answered can the very important law of supply and demand be understood.

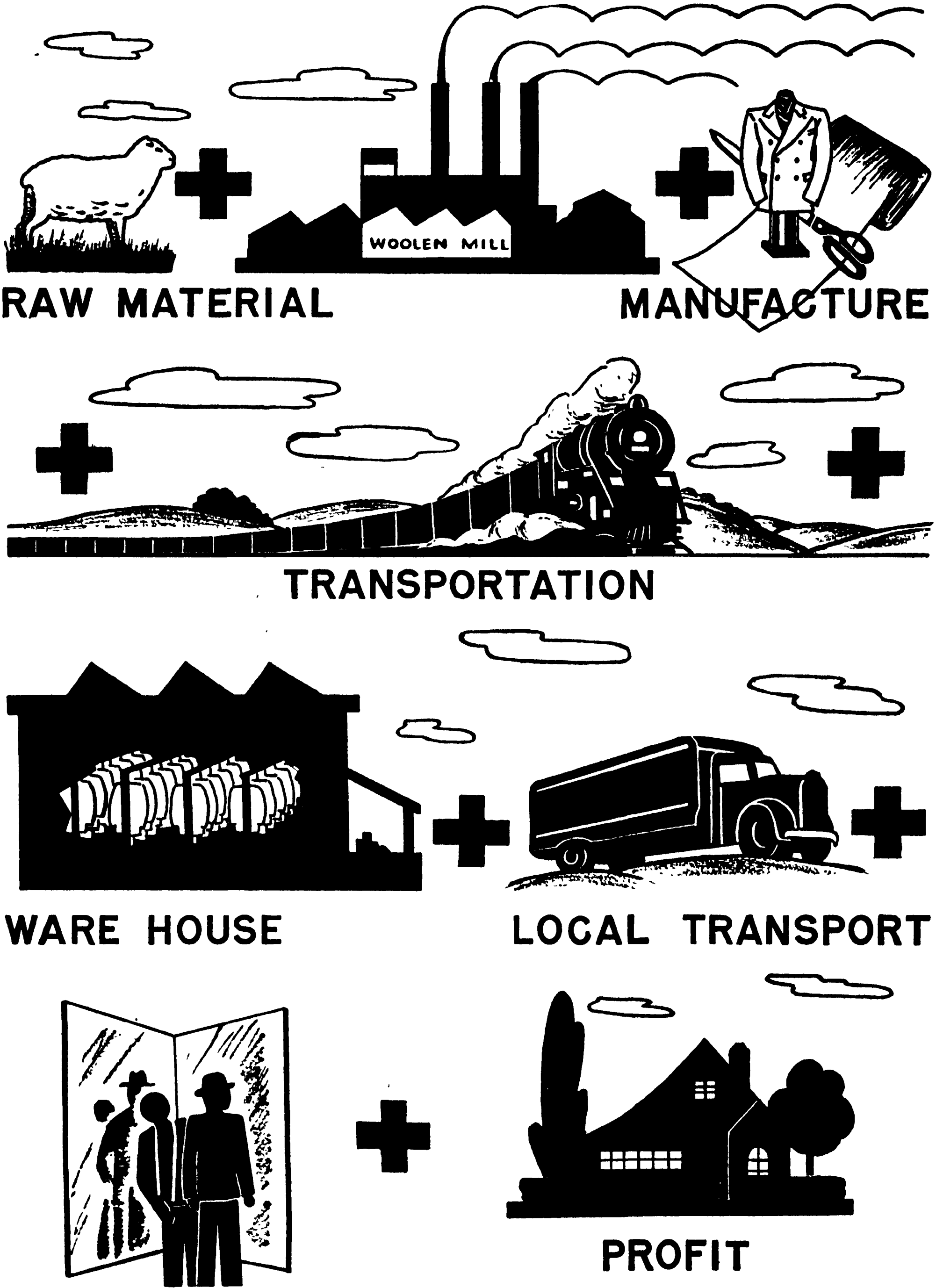
DEMAND

By demand, we mean the desire to possess a thing, combined with the ability to pay for it and the willingness to pay for it.

Tom Brown, on his way home from school, looking into the window of a candy store and seeing some nice chocolates may desire to have them, but that desire is not "demand" unless he has the money to buy, and unless, also, he is willing to buy at not more than a certain price. We see that demand in the economic sense has no meaning apart from the question of price. Suppose that Tom had ten cents to spend and that the candy he would like to buy is one dollar and fifty cents a

This picture illustrates producer goods and consumer goods. The printing press and the big rolls of paper are producer goods. They are not useful to the ordinary person—the consumer—but they produce things the consumer wants. The newspapers produced by the printing press and from the rolls of paper are consumer goods.

THE COST OF A SUIT



RAW MATERIAL + MANUFACTURE

+ TRANSPORTATION +

WARE HOUSE + LOCAL TRANSPORT +

OVERHEAD + PROFIT

A LIVING FOR THE STOREKEEPER

pound. As there are sixteen ounces to the pound, that means that the chocolates are priced at nearly ten cents an ounce, and Tom, much as he likes chocolates, would not give his money for only one ounce of them. Therefore, at such a price, his desire to buy would not be demand. If, however, the price were forty cents a pound, his ten cents would buy four ounces; that would probably turn his desire into demand, and he would go in and buy them.

WHY THE DEMAND FOR A THING VARIES WITH ITS PRICE

1. Demand usually varies with price. When price is high, the demand is less than when the price is low. We often make up our minds whether to buy this thing or that because of the question of price. Thus, if meat becomes very high in price, people, although they like to eat it, will buy less meat and more bread, because bread is cheaper than meat. Our friend, Tom, with ten cents to spend may have a number of desires to satisfy. Perhaps if he had enough to buy them all, he would buy not only candy, but a knife, a top and a ball. The question of price will help him to make up his mind which of the four things to buy. If he could buy a knife for ten cents, he might buy it instead of candy. If, however, he can not get a knife for ten cents, he might spend the money on a top or, if a good top can not be bought for ten cents, he might buy a foreign stamp or some candy. Tom, as a buyer, would be guided in the exercise of his demand by price.

No one has an unlimited amount of money to spend on any particular thing. People want many things, but have money enough for only some of them. Their desire to buy, their ability to buy and their willingness to buy, vary according to the price. If the price of a thing goes up, they buy less of it. If it goes down they buy more of it, until their desire for it has been satisfied.

2. We have just seen that the quantity of a thing which will be bought varies with the price. The demand also *varies with the need for it*. For example, in the summer people buy less coal than in the winter while, on the other hand, they buy more ice cream. Umbrellas and overshoes have a ready sale in the winter months, while in the summer cotton clothing and bathing suits are in demand. Changes in demand also occur through sheer fancy, as when it is the fashion for women to dress in velvet or in fur, or to use a particular sort of ornament.

Another interesting thing about demand is that a falling-off in the demand for one thing may be, and often is, accompanied by an increased demand for something else. During World War II butter became more expensive, not only in price, but in "ration points"; as a result the demand for it fell off. As a substitute for butter there arose a great increase in the demand for the less expensive oleomargarine.

Again, the high price of one thing may reduce the demand for another thing as well as for itself. Suppose the local gas company sharply increased the rates on its product. In that case not only the demand for gas would fall off, but also the demand for gas stoves and heaters.

3. Demand also varies greatly with spending power. If Tom has his pocket money increased, he is able to satisfy more of his wants. In addition to buying more candy, he may make a collection of postage stamps. When wages rise, working people, in addition to buying food and other necessities, may also buy luxuries such as musical instruments, or tickets to the theater or other entertainment. Many of you have seen this very thing happen during World War II.

SUPPLY

Supply means the amount of a thing that sellers are ready to offer for sale at a given price. This offering price largely depends upon two things.

1. The manufacturer or merchant will continue to offer things for sale so long as it is profitable to do so. Each will insist on a price that at least covers the cost of production.

The manufacturer must meet all the expenses of keeping up the building and the machinery, buying supplies of raw materials, and paying workmen, foremen and taxes. In addition, he has to make enough profit to pay for his time, ability and risks.

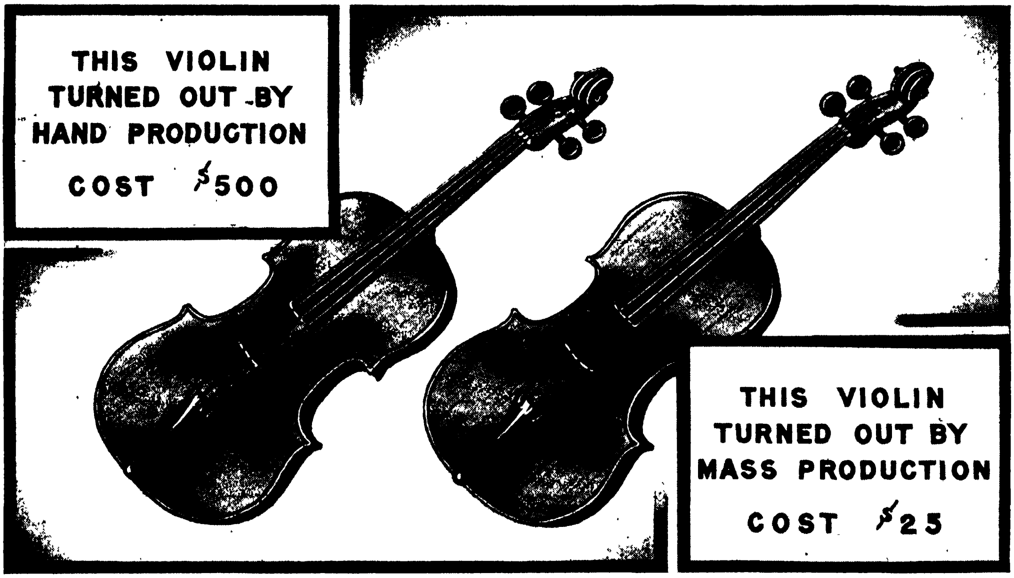
The merchant must advance the money to buy the goods, pay the expenses of shipping them to his warehouse and later placing them on the shelves of his shop; he must pay the wages of his sales force; he must pay taxes and he must include in his price a profit for himself. In either case, we see that the manufacturer or merchant could not continue supplying the goods at less than a certain price, which is the lowest he can afford to make. That is, he must at least cover the costs of doing business.

2. The exact price at which the manufacturer or merchant will offer a thing for sale may somewhat depend upon how badly he needs the money which he would get from the

sale of his goods. He might, for example, owe money at the bank which must be paid back by a certain date. Or he may be a grocer specializing in fresh fruit. If on Saturday evening he has a large supply of very ripe strawberries, he may have to cut the price per box very sharply in order to sell them all, and thus prevent complete loss from spoilage by having to keep them over the week end.

MASS PRODUCTION LOWERS PRICE

Perhaps, by producing on a large scale, a manufacturer may be able to lower the price and still make a profit. For example, suppose a printer is making a book. The cost of setting up the type is heavy, and if only ten copies of the book were printed, each of the ten copies would have to bear in its price a tenth of the cost of the typesetting. Suppose the cost of setting were $500. Then each of the ten books would cost $50 for typesetting alone. To this we should have to add the cost of paper and binding, plus the printer's profit. But suppose ten thousand copies of the book were printed. Then the typesetting would amount to only a few cents, instead of $50, for each book. It could then be sold at a reasonable price and yet yield a profit. Similarly, a newspaper, which only rich men could afford to buy if only a few copies were printed, can be sold for a few pennies because so many people buy it. Machinery aids mass production and thus brings prices down.



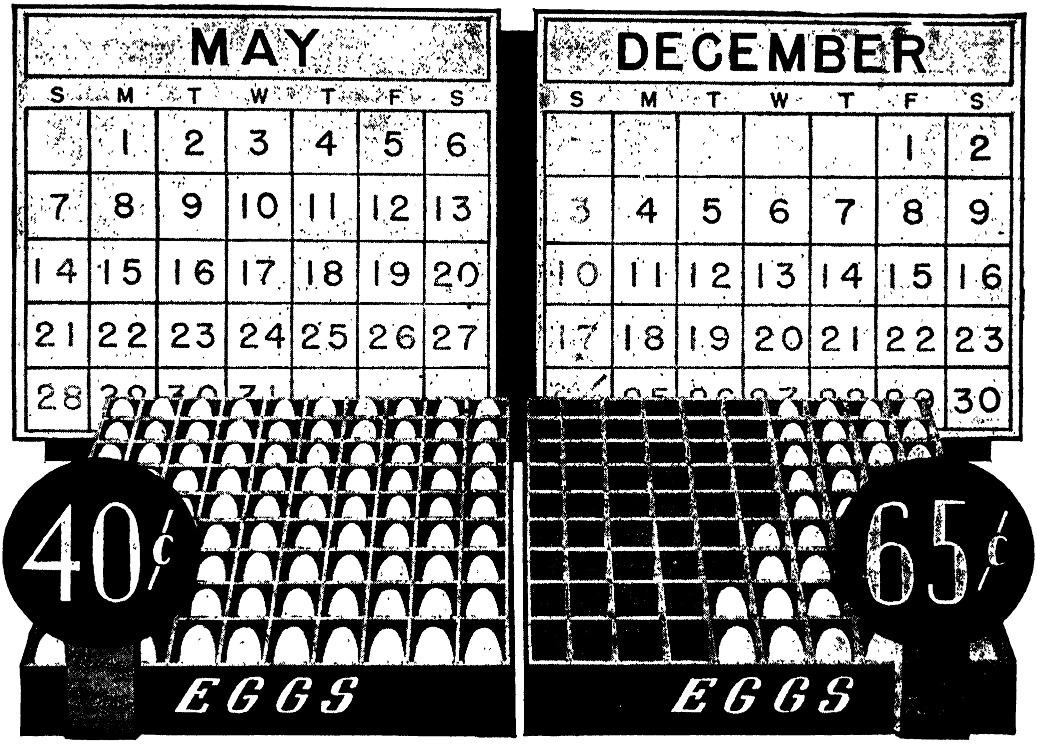
Here is a good example of the fact that machinery aids mass production and thus brings down prices. One violin, made entirely by hand, costs $500. The other one, turned out in a fraction of the time by machinery, costs only $25. The cost of wood and strings is the same. The difference is in cost of labor.

It is, of course, very difficult in actual business for anybody to decide at just what price a certain supply of goods can be sold. It sometimes takes great courage and enterprise for a merchant to take a large quantity of a certain article in the hope that the price at which he can offer it can be met by the demand of persons willing and able to buy at that price.

Price stands between demand and supply and is a result of their action upon each other. Price is affected by them in opposite ways. Rising prices lead to a greater supply and a smaller demand. Falling prices, on the other hand, lead to a smaller supply and a greater demand. It is equally true that a bigger supply or a smaller demand leads to lower prices, and that a smaller supply or a bigger demand leads to higher prices.

THE LAW OF SUPPLY AND DEMAND

In the market, whether it is in books and newspapers, in tea, or sugar, or steel or shares of stock, price is set at any given moment by the supply and the demand. If there are more buyers than sellers, up goes the price. If there are more sellers than buyers, down goes the price. These ups and downs in price do not depend upon the value in use of the articles.



When the demand for an article remains the same, and the supply goes down, the price goes up. In May, eggs in the store are plentiful because hens are laying plenty of them; so eggs are cheap. In December, the hens lay fewer eggs, yet the demand for them in the store is the same; so they cost much more than they did in May.

The same book at $1.95 is just as interesting as though it sold for $10. Tea of the same quality is just as good to drink whether it is cheap or whether it is expensive; its price on the market depends on the relation of supply to demand.

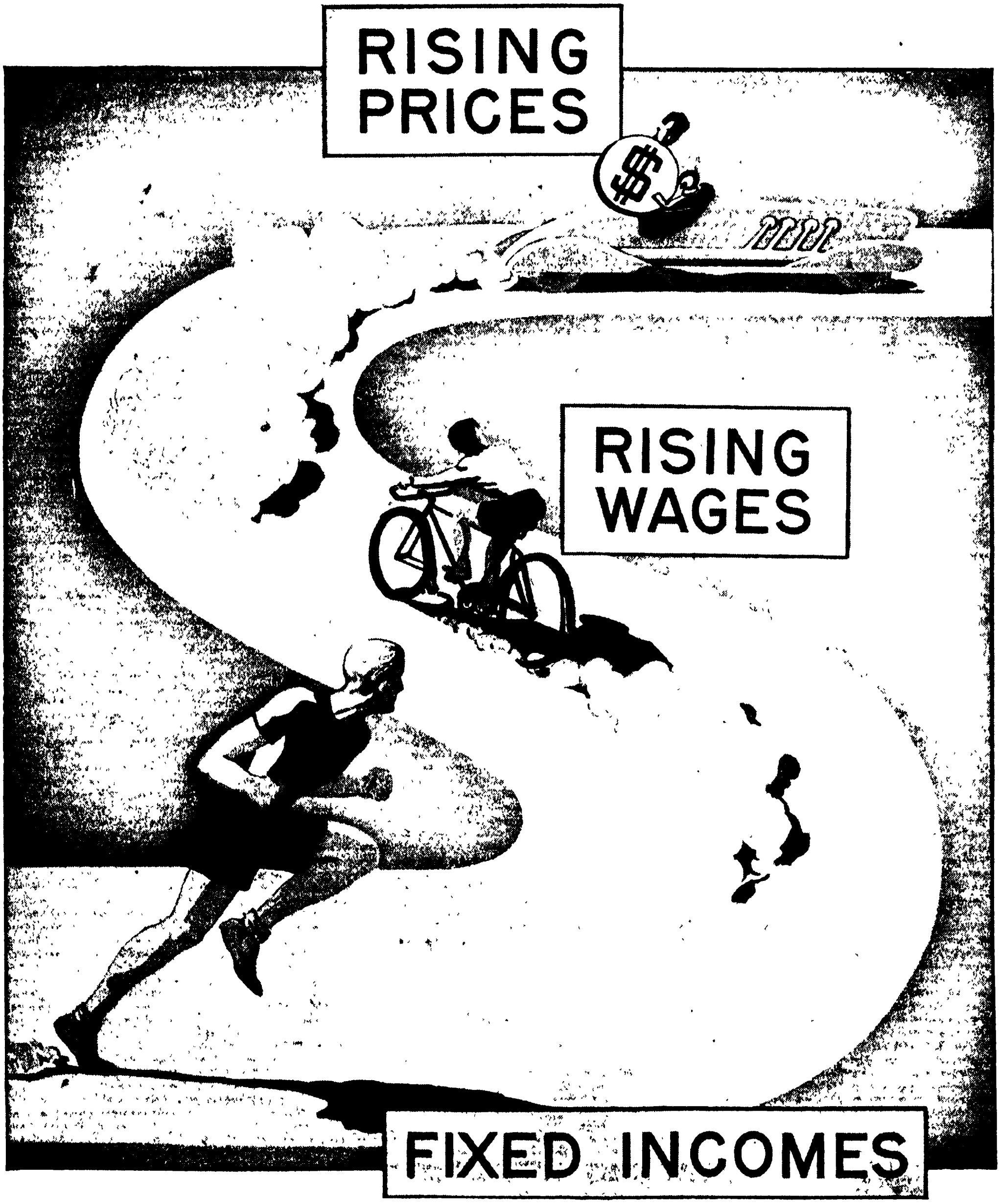
No matter how valuable a thing in use may be, if a large quantity of it comes on the market at one time, its price will fall. For example, once very few automobiles were made, and then only by hand and at a very great cost. The supply was small, and few could pay the price. The equality of supply and demand was reached, therefore, at a very high level, and only rich men could possess cars. Nowadays, through mass-production methods, far better automobiles and many more of them can be made in great factories by machinery, so that they can be offered profitably at almost a tenth of the price of the first hand-made automobiles; and the result is a greatly increased demand. Mass-production by bringing down prices, helps us to have many of life's comforts.

In talking about demand and supply, it must be remembered that the amount of labor put into a thing does not necessarily determine its value in use or in exchange. For example, a man might spend a week digging a hole in the ground where none was wanted, and then, because he had worked hard, insist that the hole was worth something. We could only reply that it was a pity he had wasted his time.

Even though a manufacturer produces a useful article, he can not long stay in business unless he can produce his goods cheaply. Imagine there are two coal mines, and that from one of them coal can be got easily; while from the other, because the seams of coal are thin, it is more costly to get the mineral. You would not offer a higher price for the coal from the poor mine. The coal will bring the same price for the same quality on the same day, whether it comes out of a good mine or a poor one, or whether it costs much or little to get.

Now that we understand why a person is willing to give a certain price for a thing he wants, and why he must pay a certain price to get the thing wanted, we are ready to state the law which governs all market transactions everywhere and at all times. It is known as the law of *supply and demand.* In a nutshell, it is this: *When supply is greater than demand, the price falls; when supply is smaller than demand, the price rises.* When prices are too low, so that those who make the goods and those who sell them can not receive enough money to live on, a country has depression, or "hard times."

When prices are very high and goods remain scarce, we have inflation (see page 5937). Both inflation and depression, once started, tend to get worse, if the government does not take a hand in stopping them.



INFLATION

Even a small shortage of supply or a small increase in demand may cause a considerable difference in price. When supplies run very short, the rise in prices may be very serious indeed; then those who have things to sell make very great profits. Serious inconvenience and even suffering may be the result for many people. To such a condition economists apply the word inflation, because the prices go up and our dollars will not buy as much as they used to.

Such a rise in prices would not matter so much if all prices rose in the same proportion, including wages (the price of work). But, unfortunately, during inflation some prices rise much faster than others, while still others may not rise at all. For example, the price of wheat per bushel might stay the same; while a great increase might take place in the manufactured things, such as plows and clothing, which the wheat farmer must buy. Thus, while he still received the same number of dollars for the wheat he sells, each dollar would buy less of the things he needs than before.

There are also large groups of people, such as clerks, bookkeepers, teachers and those living on an income from pensions, bonds or insurance, whose income in dollars stay the same. That means they can either buy less of the things they did before, or go without some of them entirely.

WARTIME GOVERNMENT PRICE CONTROL

Inflation usually occurs in time of war. That is because the supply of dollars rapidly increases, while the supply of consumer goods, such as shoes, canned goods, automobiles and tires, decreases. The raw materials formerly used in making these articles now go into the making of tanks and guns and other things necessary to carry on a successful war. Also, through the offer of high wages, many workers are drawn from peacetime occupations into war plants. As a result there are fewer goods on the market, but more dollars with which to buy them. Naturally, if we understand the law of supply and demand, we know that prices must go up. But even worse than the inflation itself is the business collapse and depression which follows the war boom. The war factories stop running, and many people have no work for a time. The supply of money decreases. Demand for goods suddenly drops, prices decline, banks fail, even peacetime factories close, and millions more are thrown out of work. The widespread distress which follows may last for months or even several years.

As each country entered World War II, the supply of some articles soon became scarce. As a result prices began to go up. After three years of war, it took a dollar in the United States to buy what could formerly be bought for seventy cents. This rise was not bad compared with the inflation of World War I, when prices more than doubled. Prices rose much more rapidly in some of the other countries. For example, in the summer of 1944, it would take thirty-five American dollars to buy an ordinary dinner in Russia. In China a loaf of bread cost fifteen dollars.

Very early in the war, most governments took steps to check inflation. Every few months War Bond buying drives were made in order to get people to invest in them. There were three reasons for this. The governments needed the money to buy guns and planes and other war materials (including military services); money invested was taken out of the market, thereby holding back the rise in prices; and money so invested was "money in the bank," to be spent for necessary things later. In addition, very high taxes were levied by every government. The taxes reached down deep into everybody's pocket, taking at least 20 per cent of our income. Finally, "price ceilings" were set on most goods, above which the merchant could not charge. In most of the Allied countries inflation was kept under control by such measures, though not completely prevented. As a result the people with fixed incomes were not inconvenienced nearly so much as in past wars.

Let us briefly sum up what we have learned. The things we want and need have use value. If they are scarce, so that we must pay for them or work for them, we say they are economic goods and have economic value, which we generally call exchange value.

Price is the amount of money we give for a thing (exchange value expressed in money). Prices rise and fall according to supply and demand. When the supply is greater than the demand, the price tends to fall. When the demand is greater than the supply, the price rises. When prices are very low, they tend to go lower, and we have depression. When demand is much greater than supply, prices tend to rise higher and higher, and we have inflation.

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THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 6083.

SCIENCE

ORGANIC CHEMISTRY — CARBON COMPOUNDS

A GOOD many years ago, before the first part of the nineteenth century, the products of animal and plant life were looked upon as being something mysterious. It was felt that these products came from some living force and man could not hope to make them in his laboratories. The chemist studied them carefully, however, and he called these products of living things organic compounds. As knowledge of them increased, the attention of the world's best scientists was drawn more and more to this new field of organic chemistry. Finally, in 1828, a German chemist, Frederick Wöhler, triumphantly announced that he had made the first organic compound. By warming ammonium cyanate, an inorganic compound which any chemist could make in the laboratory, he had formed urea, a waste material of the body. Both urea and ammonium cyanate have the same formula, N_2H_4CO, and the same molecular weight! The arrangement of the atoms, however, is different in the two molecules. Compounds with the same formula and the same molecular weight but with a different arrangement of the atoms are called isomers; and they have different properties.

With the news of Wöhler's startling discovery, the barrier was completely broken down between the inorganic chemistry of the lifeless rocks and metals, and the organic chemistry of the products of animal and plant life. Scientists soon found that the fundamental principles and laws of organic chemistry were the same as those of inorganic chemistry. It was also discovered that almost all the most important substances found in plants and animals contain the element carbon. And so the chemist began to call his study of organic chemistry the study of carbon compounds. That is a much better term for it.

After Wöhler's discovery that man could put together, or synthesize, organic com-

Esso Marketers photo

Specimens of gasoline and other petroleum products which are to be analyzed by laboratory workers. Petroleum is the commonest and probably the most important of all the hydrocarbons, or compounds of hydrogen and carbon.

pounds, chemists turned to organic chemistry in increasing numbers, until today more chemists are engaged in the study of carbon compounds than in any other field of chemistry. With so much effort concentrated on organic chemistry, the list of carbon compounds known grew rapidly. It now numbers over 300,000. Many new organic compounds have been discovered; and several new branches of organic chemistry have been established as a result of the intensive research done by chemists during World War II.

The study of organic chemistry is of interest not only to the chemist, but also to men of many other professions. In its earliest days organic chemistry was linked with the study of living things, and this is still true today. The doctor places great dependence upon organic chemistry, and his training includes knowledge of this field. He knows that the chemist can make many of the healing compounds found in nature and can form new compounds that are better for controlling disease or relieving suffering. Novocain (procaine) was made by a chemist, Einhorn, in 1905, while he was searching for a better local anesthetic than could be found in plants, and the wide use of this drug by doctors and dentists in preventing pain is a tribute to organic research.

CARBON COMPOUNDS PLAY AN ALL-IMPORTANT PART IN OUR MODERN INDUSTRY

Many of our industries owe their existence to carbon compounds. Plastics are carbon compounds. Rayon and some other man-made fibers are carbon compounds. Commonplace items like soap, rubber and vegetable fats have been greatly improved by the work of the organic chemist. Coal tar is a mixture of carbon compounds, and from coal tar have come nearly all the dyes we use, many drugs, perfumes and flavors. The most noted organic chemist of the past generation, Emil Fischer, was a pioneer in the study of coal-tar dyes.

The petroleum industry which started with the drilling of the first oil well in Titusville, Pennsylvania, in 1859, has grown to be one of America's leading industries. The crude gasoline first used by the early automobiles has little resemblance to the modern high-octane gasolines or aviation fuels developed by the chemist. From petroleum the chemist has also made synthetic rubber. It has been found to be better than natural rubber for some uses, especially where the rubber comes in contact with oil or grease.

The list of substances made or developed by the organic chemist is impressive. But these things were not accomplished by waving a wand and pulling a rabbit from a hat. They are the result of the unceasing toil and countless experiments of many men for many years. The wonderful materials formed by modern chemistry—the plastics, the synthetic rubbers, or the rayons—are not so important to the organic chemist as the knowledge he has gained from the studies that led to these discoveries. From this knowledge gathered bit by bit throughout the years has grown the great modern science of organic chemistry—the study of carbon compounds.

Let us look first at hydrocarbons, since they are so abundant and so important. Hydrocarbons are compounds of hydrogen and carbon. They occur as gases, liquids and solids. They are found in the gases formed by heating coal or wood in a closed vessel. Petroleum and natural gas are almost entirely made up of hydrocarbons. Turpentine and rubber are also hydrocarbons.

CARBON COMPOUNDS ARE GROUPED IN FAMILIES, CALLED HOMOLOGOUS SERIES

Carbon compounds are very numerous, and it is easier to study them if they are arranged in groups, or families, which are called homologous series. Members of a family, or homologous series, have the same general formula and similar chemical properties. Each member of a homologous series differs from the one below it and the one above it by one atom of carbon and two atoms of hydrogen, or by CH_2. The table below contains some members of the methane, or paraffin, series of hydrocarbons.

Homologous Series of Paraffins: General formula C_nH_{2n+2}

CH_4	Methane	Gas
C_2H_6	Ethane	Gas
C_3H_8	Propane	Gas
C_4H_{10}	Butane	Gas
C_5H_{12}	Pentane	Liquid
C_6H_{14}	Hexane	Liquid

With increasing molecular weight, that is, with more atoms of carbon and more atoms of hydrogen, the hydrocarbons tend to become solids, and their boiling points rise. Thus $C_{18}H_{38}$, octadecane, is a solid that melts at 28° C. There are other series of hydrocarbons represented by the ethylene series with the general formula C_nH_{2n}; and the aromatic series, C_nH_{2n-6}, like benzene and toluene. These are found to some extent in petroleum.

Methane, CH_4, is the first member of the paraffin series. It is called marsh gas because it is found in marshes and stagnant pools, and is formed by the decay of vegetable matter. It may sometimes be found in coal mines and is known to the miner as "fire-damp." Methane is a colorless, odorless and tasteless gas, and does not disssolve in water. Like other members of the paraffin series, it does not react with most chemical reagents. Like all hydrocarbons it burns, forming water and carbon dioxide and giving off considerable heat.

$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$$

Methane + Oxygen yields Water + Carbon Dioxide

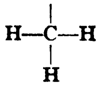
A mixture of methane and oxygen (or air) is extremely explosive.

The organic chemist explains the structure of the organic compounds by means of structural formulas. Before the middle of the last century there was a great deal of confusion regarding the formulas of carbon compounds. After the invention of the structural formula had enabled the chemist to understand and picture the construction of the carbon compounds, organic chemistry advanced rapidly. The chemist who did most to advance the structural formula was Frederick Kekulé. The organic chemist, by this system, expresses not only the number and kinds of atoms in the molecule, but also the way in which they are linked together. There are two facts that are important in learning to write structural formulas.

1) Carbon always has a valence of four, hydrogen always has a valence of one, and oxygen always has a valence of two. By valence the chemist means the number of hooks, or links, an atom has, with which to join other atoms.

2) Atoms of carbon can not only combine with atoms of other elements, but can also combine with one another in a chain. It is this formation of chains that largely accounts for the vast number of carbon compounds.

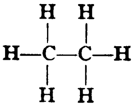
Let us see how the chemist would picture methane with a structural formula.



$$\begin{array}{ccccc} & & H & & \\ & & | & & \\ H & - & C & - & H \\ & & | & & \\ & & H & & \end{array}$$

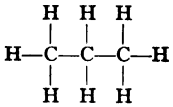
The dash (–), whether horizontal or vertical, stands for a link, or valence bond, which joins the atoms together. Here the carbon atom has four links, and the hydrogen atoms each have one.

(The chemist uses a single dash to indicate a link between atoms.) The structural formulas for ethane and propane, the second and third members of the paraffin series, are shown below.



$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

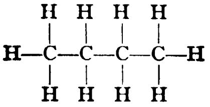
Ethane



$$\begin{array}{ccccccccc} & & H & & H & & H & & \\ & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & \\ & & H & & H & & H & & \end{array}$$

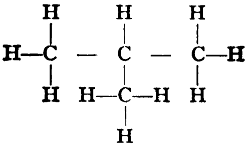
Propane

The paraffins are called "straight-chain" compounds because the carbon atoms are arranged in chains like —C—C—C—. The carbon atoms in butane and the larger hydrocarbons can be arranged either in straight chains or in branched chains.



$$\begin{array}{ccccccccccc} & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & \\ & & H & & H & & H & & H & & \end{array}$$

Butane
(straight chain)



Butane
(branched chain)

Thus there are two kinds of butane. They both have the same number of carbon atoms and hydrogen atoms, but these atoms are arranged in different structures. This is called isomerism. As we have said, isomers are compounds with the same number and kinds of atoms, but with different structural arrangements; they have different chemical properties. For example, at 0° C. the straight-chain butane, or normal butane, is a liquid, and the branched-chain butane, or isobutane, is a gas. The more carbon atoms there are in a hydrocarbon, the greater the number of isomers it is possible to make. In a hydrocarbon containing forty carbon atoms, calculations show that there are 69,491,178,805,831 possible isomers. Of course, only a very few of these have been prepared.

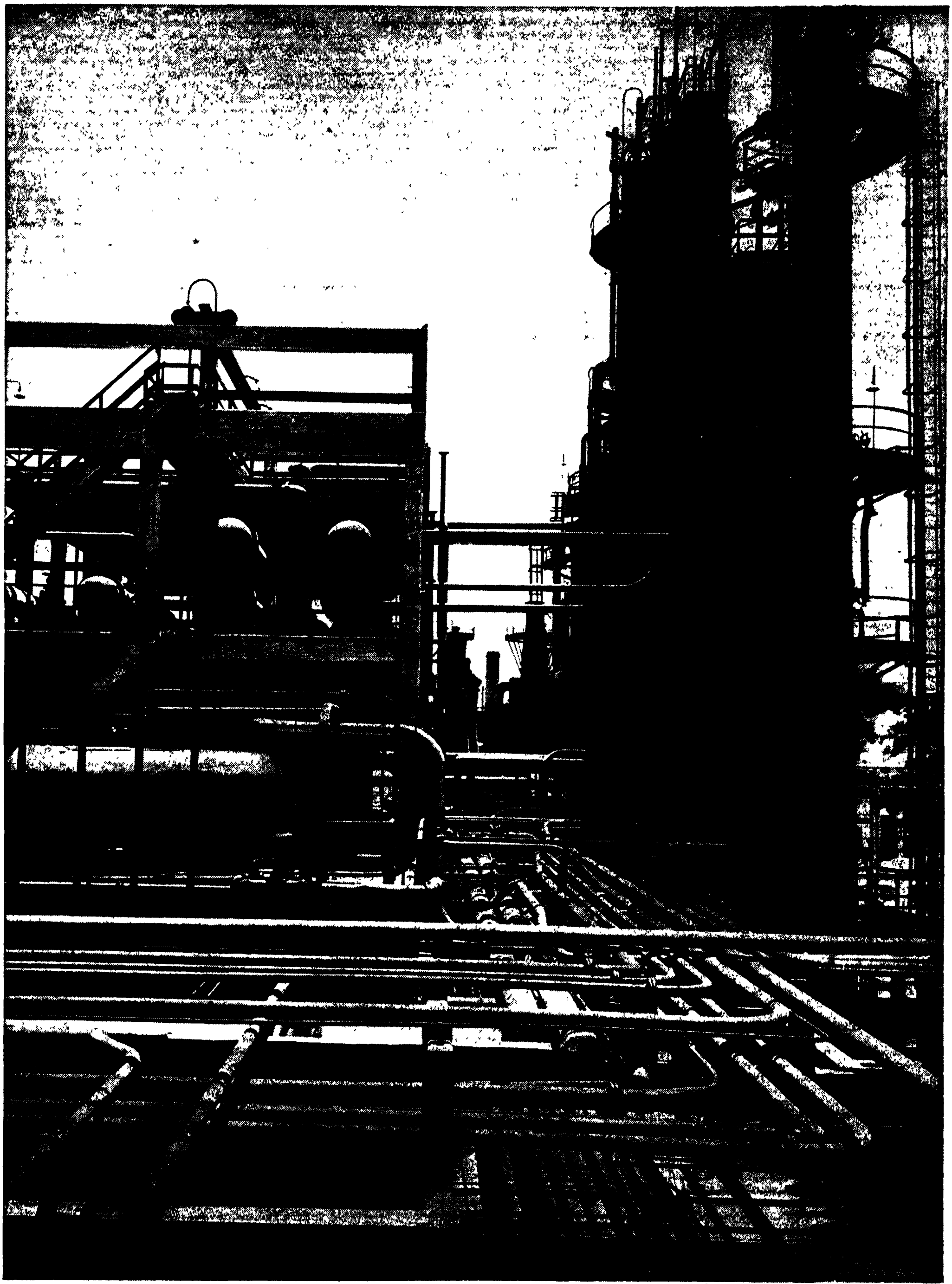
When members of the paraffin series are heated to high temperatures (300° C. to 600° C.), they break down into smaller molecules. A simple example is the breakdown of pentane.

$$\underset{\text{Pentane}}{C_5H_{12}} \xrightarrow{500° \text{ C.}} \underset{\text{Propylene}}{C_3H_6} + \underset{\text{Ethane}}{C_2H_6}$$

The products formed by heating paraffins are very numerous.

The most common and probably the most

FROM CRUDE OIL TO GASOLINE



Courtesy, The Texas Company

A "cracking" unit, which breaks down the hydrocarbons of crude oil by heating to high temperatures. Left: the pump house; right, the "cracking" equipment. Much of our gasoline is now manufactured by this process.

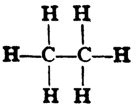
important mixture of hydrocarbons is petroleum. The oil that comes from oil wells is called crude oil and needs considerable treatment, or refining, before it is usable. A wide variety of products is made from petroleum by separating groups of hydrocarbons. This is done by heating and is called distillation. The gases that boil at lowest temperature are given off first, and these are used as fuels. As the temperature of the petroleum is raised, hydrocarbons with five and six carbon atoms are given off, and these are used as solvents for rubber and varnish. The next group, which is the material that boils between 85° C. and 200° C., is used as gasoline. Material that boils between 200° C. and 300° C. is called kerosene. The tarry residue which is left is one of two types, depending upon the source of the oil. Pennsylvania oils leave paraffin, and Mexican and California oils usually leave a thick, black pitch called asphalt, which is used in paving streets.

The most desired product of petroleum is gasoline, but our supply would be very limited if our only source were the small fraction distilled from petroleum. In order to provide more gasoline the organic chemist discovered the process called "cracking." A large part of our gasoline is now manufactured by this process. "Cracking" is just breaking down hydrocarbons by heating crude oil to high temperatures. Nearly three times as much gasoline can be obtained when the oil is "cracked" than if the oil were merely heated as in the ordinary distillation.

HYDROCARBONS WHICH COMBINE READILY WITH BROMINE AND CHLORINE

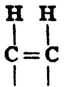
When crude oil is "cracked" large amounts of hydrocarbons which are not members of the paraffin series are usually formed. These hydrocarbons, unlike the members of the paraffin series, combine readily with bromine and chlorine, and they are called unsaturated hydrocarbons. Unsaturated hydrocarbons combined with chlorine yield olefins.

The first member of the olefin series is ethylene, which is a colorless gas with a sweetish odor. It burns with a luminous, smoky flame, and when it is mixed with air it is extremely explosive. Structural formulas of ethylene and ethane are:



$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

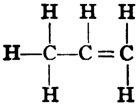
Ethane
(saturated)



$$\begin{array}{ccc} H & & H \\ | & & | \\ C & = & C \\ | & & | \\ H & & H \end{array}$$

Ethylene
(unsaturated)

Ethylene has two less hydrogen atoms than ethane, and consequently it has two links, or valence bonds, that must be joined. Here one carbon atom is joined to the other carbon atom by two links. But notice that each carbon atom still has four bonds. When one carbon atom is joined to another carbon atom of a chain hydrocarbon by two or three bonds, the hydrocarbon is called unsaturated. A saturated hydrocarbon has all carbon atoms joined together by only one bond, like the paraffins. Let us picture propylene, next in the olefin series.



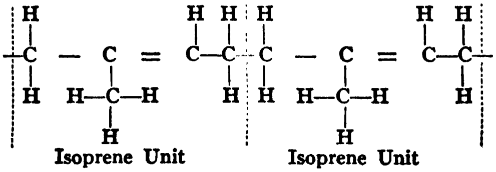
$$\begin{array}{ccccccc} & & H & & H & & H \\ & & | & & | & & | \\ H & - & C & - & C & = & C \\ & & | & & & & | \\ & & H & & & & H \end{array}$$

Propylene

The olefins, like the paraffins, are insoluble in water, but unlike the paraffins they are very reactive and combine with a great variety of substances. They react with chlorine and bromine and with acids. They also react with hydrogen to form paraffins.

$$\underset{\text{Ethylene}}{C_2H_4} + \underset{\text{Hydrogen}}{H_2} \xrightarrow{\text{Catalyst}} \underset{\text{Ethane}}{C_2H_6}$$

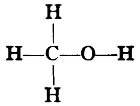
The olefins are important carbon compounds in the chemical industries for they are used as starting-points in the manufacture of many products. A knowledge of the behavior of unsaturated hydrocarbons is important to the organic chemist. The chemistry of rubber is to a large extent the chemistry of unsaturated hydrocarbons. Pure rubber is changed to the commercial rubber of automobile tires and rubber tubes by heating it with 4 to 5 per cent of sulfur. This process is called vulcanizing. Rubber is a polymer, which means that it is a large molecule made up of a great number of identical small units. The basic unit in rubber is isoprene; here is its formula.



Isoprene Unit   Isoprene Unit

By looking at the structural formula, you see that the isoprene unit is an unsaturated hydrocarbon. Rubber consists of a chain of many hundreds of these isoprene units. At each end of the chain there is, of course, a hydrogen atom instead of the free links shown above. It was from a study of the unsaturated hydrocarbons and by a knowledge of the structure of rubber that chemists were able to make synthetic rubbers.

One of the most important classes of organic compounds is the alcohols. They are widely used by many industries as solvents and as raw materials for the manufacture of many other organic substances. In a recent year more than 700,000,000 gallons of alcohols were produced. The most common alcohols are methyl alcohol and ethyl alcohol, which are the first two members of a homologous series. The structural formula for methyl alcohol is written as follows:



$$\begin{array}{ccccc} & & H & & \\ & & | & & \\ H & - & C & - & O-H \\ & & | & & \\ & & H & & \end{array}$$

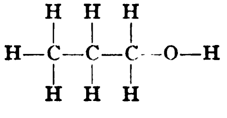
Methyl Alcohol

Here you see the fundamental characteristic of an alcohol—it contains an O-H group called an hydroxyl group. The lower members of the alcohol series resemble water in many reactions, and this does not seem strange if the formulas for water and an alcohol are compared. Water is familiar to everyone as H_2O, but this can also be written H-O-H, and it is apparent that water also contains the O-H or hydroxyl group. Alcohols may be thought of as coming from paraffins by the substitution of OH for H.

Homologous Series of Alcohols

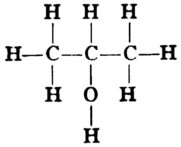
CH_3OH	Methyl alcohol	Liquid
C_2H_5OH	Ethyl alcohol	Liquid
C_3H_7OH	Propyl alcohol	Liquid
C_4H_9OH	Butyl alcohol	Liquid
$C_5H_{11}OH$	Amyl alcohol	Liquid

As in the case of the hydrocarbons, alcohols also have isomers. Thus there are two propyl alcohols.



$$\begin{array}{ccccccc} & H & & H & & H & \\ & | & & | & & | & \\ H- & C & - & C & - & C & -O-H \\ & | & & | & & | & \\ & H & & H & & H & \end{array}$$

Normal Propyl Alcohol



$$\begin{array}{ccccccc} & H & & H & & H & \\ & | & & | & & | & \\ H- & C & - & C & - & C & -H \\ & | & & | & & | & \\ & H & & O & & H & \\ & & & | & & & \\ & & & H & & & \end{array}$$

Isopropyl Alcohol

Methyl alcohol is the first member of the series. It is commonly known as wood alcohol. This is because the first commercial method for its preparation was to heat wood in a closed vessel, catching the vapors which were given off. These vapors contain about one per cent methyl alcohol. A method has been developed which produces methyl alcohol more cheaply than by distilling wood. Water-gas, which consists of carbon monoxide and hydrogen $(CO+H_2)$, is made by passing water vapor over red-hot coke.

$$\underset{\text{Water}}{H_2O} + \underset{\text{Carbon}}{C} \longrightarrow \underset{\text{Water-Gas}}{(CO+H_2)}$$

Under high pressures and temperatures and in the presence of a catalyst, water-gas forms methyl alcohol.

A catalyst is a substance which changes the speed of a chemical reaction, but does not itself take part in the reaction. Catalysts are very useful in industry, for by means of catalysts many reactions which might otherwise take a long time are speeded up and made commercially profitable.

Methyl alcohol is a colorless liquid with a wine-like odor. It mixes with water in all quantities. Methyl alcohol is poisonous and should never be taken internally.

ETHYL ALCOHOL, PREPARED BY THE FERMENTATION OF SUGAR OR MOLASSES

The second member of the alcohol series is ethyl alcohol. It has been prepared since ancient times by the fermentation of sugar or molasses. This fermentation is brought about by the action of a natural catalyst called an enzyme. When yeast is placed in a sugar solution, it is the action of an enzyme in the yeast which causes the fermentation. The sugar changes into ethyl alcohol and carbon dioxide. Ethyl alcohol is also made from grain by the action of another enzyme.

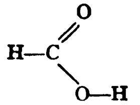
Both ethyl alcohol and methyl alcohol are greatly used in industry, since they are comparatively cheap. They are used widely as solvents, since they dissolve many substances which are insoluble in water. Ethyl alcohol is similar to methyl alcohol in many of its properties. However, it has a higher boiling point and it is not poisonous if taken internally. The sale of ethyl alcohol is carefully controlled and it carries a heavy tax. It can be sold tax-free if it is made unsuitable for drinking, and this is usually done by the addition of methyl alcohol and strong-smelling substances which serve as a warning that the ethyl alcohol is poisonous. This treated ethyl alcohol is called denatured alcohol.

The other members of the alcohol series do not have as much commercial importance as methyl and ethyl alcohol, but there has been a steady development in the industrial uses of the higher alcohols.

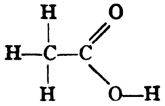
Another important class of carbon compounds is the organic acids. These acids are weak acids when compared with the inorganic acids like hydrochloric and sulfuric acid. But they are strong enough to turn blue litmus red, a test for acid. The

Courtesy, National Carbon Company, Inc.
Ethylene glycol, an alcohol, is used as an anti-freeze.

first two members of the organic acid series are formic acid and acetic acid, and their formulas are shown below.

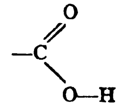


Formic Acid



Acetic Acid

This class of carbon compounds contains the group



called the carboxyl group, and this is to be found in all organic acids. The series is sometimes called the fatty-acid series, due to the preparation of two of its members, palmitic and stearic acids, from animal fats.

Formic acid is found in nettles and ants. The sting of a bee is partly due to formic acid. One of the earliest methods for preparing formic acid was to distill red ants. One of the modern preparations is to oxidize methyl alcohol in the presence of a platinum catalyst.

$$O_2 + CH_3OH \xrightarrow{\text{Platinum}} H_2O + HCOOH$$

Oxygen Methyl Alcohol Water Formic Acid

Formic acid is a colorless liquid, with an irritating odor. It is used in dyeing cloth and in the textile industry.

Acetic acid is the second and most important member of the fatty-acid series. It is commonly found in two forms, glacial acetic acid, which is concentrated acetic acid, and vinegar, a very dilute acetic acid.

Vinegar is still made by the original process of fermentation of fruit juices. The juices form alcohol by fermentation, and when the alcohol solution is exposed to the air for a long period of time, vinegar is formed. This is brought about by a microorganism known as "mother of vinegar" which is present in the juices.

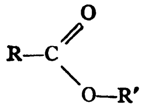
$$CH_3CH_2OH + O_2 \longrightarrow CH_3COOH + H_2O$$

Ethyl Alcohol Oxygen Acetic Acid Water

Glacial acetic acid can be made from acetylene, and this comparatively new method is gaining widespread use because of its low cost. Pure acetic acid is a white solid which melts at 16.6° C. and boils at 118° C. It is soluble in all proportions in water, alcohol and most organic solvents. Because of its low cost, acetic acid is used as a starting-point in the manufacture of many organic compounds.

In general, organic acids are prepared by the oxidation of the corresponding alcohol. (Oxidation, you know, means forming a compound with oxygen.) The smell of rancid butter comes from butyric acid, which is the fourth member of the fatty-acid series.

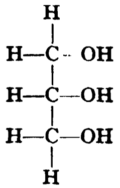
When an alcohol and an organic acid react, a new class of organic compounds, called esters, is formed. The general formula for an ester is



R and R′ are the chemist's abbreviations for alkyl groups, such as a methyl, CH_3, or ethyl, CH_3CH_2, group. Esters have a pleasant, fruity odor and are found in many fruits and flowers. Artificial perfumes and flavors are made from esters. A list of some of these common esters is given below.

Formula	*Name*	*Odor*	*Use*
$CH_3COOC_5H_{11}$	Amyl acetate	Pear	Flavor
$CH_3(CH_2)_9COOC_5H_{11}$	Amyl undecylate	Rose	Perfume
$C_3H_7COOCH_3$	Methyl butyrate	Pineapple	Flavor
$CH_3COOC_8H_{17}$	Octyl acetate	Jasmine	Perfume

When a special type of alcohol, called glycerol, or glycerin, combines with organic acids of high molecular weight, a fat or vegetable oil is formed. Glycerol is a viscous, colorless liquid and its formula is:

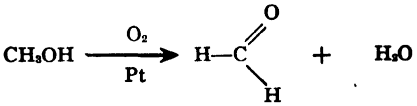


Glycerol

You can see from the structural formula that glycerol is a type of alcohol, since it has the characteristic O-H, or hydroxyl, group. When organic acids like palmitic acid, $C_{15}H_{31}COOH$, and stearic acid, $C_{17}H_{35}COOH$, react with all three hydroxyl groups in glycerol, a fat or oil is formed. The esters of glycerol are called glycerides, and the various fats, such as butter and oleomargarine, or oils, such as olive oil and linseed oil, are composed of different mixtures of glycerides.

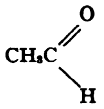
The glycerides are important in the manufacture of soap. Soap is the potassium or sodium salt of a mixture of fatty acids containing ten or more carbon atoms. Soap is made from animal fats or vegetable oils by boiling the fats or oils with sodium hydroxide. Both soap and glycerol are the products in soap manufacture, and most of the world's glycerol supply comes from the soap industry. Glycerol is used to make nitroglycerin, an explosive, and other organic compounds.

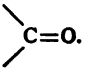
Three new classes of carbon compounds are made from alcohols. By carefully oxidizing a normal alcohol, an aldehyde is formed. The most common members of the aldehyde class are the first two—formaldehyde and acetaldehyde. Formaldehyde is made by heating methyl alcohol in the presence of air and a copper or platinum catalyst.

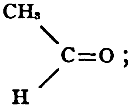


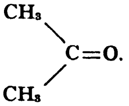
Methyl Alcohol　Formaldehyde　Water

Formaldehyde is a gas with a characteristic sharp odor. It is used as a disinfectant and preservative. When combined with phenol it forms the plastic known as Bakelite.

Acetaldehyde,  , is a colorless liquid, made from ethyl alcohol.

Ketones are also made by oxidizing alcohols. The commonest ketone is acetone, **which is a colorless liquid that boils at 56° C. and is used generally as a solvent. Acetone is made commercially from calcium acetate, although increasing quantities now come as a by-product in the manufacture of butyl alcohol. Both aldehydes and ketones contain the same structural group, called the carbonyl group,** **.**

The difference between an aldehyde and a ketone is that the carbonyl group of an aldehyde has a hydrogen atom attached to one of the bonds of the carbon atom, as in acetaldehyde,  **; while a ketone has two carbon atoms attached to the links of the carbonyl group, as in acetone,**



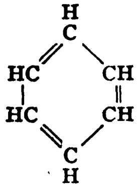
Both aldehydes and ketones are very reactive, and they are used by the organic chemist as tools in making complex organic compounds.

The third class of carbon compounds made from alcohol is the ethers. The most familiar member of the ether series is the second ethyl ether, a sweet-smelling, colorless liquid, which is the ether used as an anesthetic. The formula for ethyl ether is: $CH_3CH_2\text{-}O\text{-}CH_2CH_3$. This shows the characteristic structure of an ether which is R-O-R′; an oxygen atom linking two alkyl groups.

THE AROMATIC COMPOUNDS YIELD A GREAT NUMBER OF INDUSTRIAL PRODUCTS

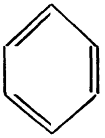
All of the classes of organic compounds considered up to this point have been chain compounds. One of the most important branches of organic chemistry is the cyclic or ring branch. The most important class of cyclic compounds is the aromatic compounds. These substances are largely prepared from coal tar, which is a by-product in the manufacture of coke from coal. The number of familiar products of coal, water and air increases daily. Dyes, plastics, perfumes, flavors and drugs are just a few of the commonplace items whose low cost and widespread use has been made possible by aromatic chemistry.

The simplest aromatic compound is benzene; and a great deal of knowledge about aromatic compounds can be obtained from a study of the structure and properties of benzene. In 1825 Michael Faraday discovered benzene, but it was not until after 1866 that Kekulé proposed the present structural arrangement. Then aromatic chemistry started to advance rapidly. Benzene contains six carbon atoms and six hydrogen atoms, so that it must be unsaturated; that is, some of the carbon atoms must be joined together by two links. But, unlike the unsaturated hydrocarbons, benzene does not react with bromine. The structural formula for benzene is a ring, or cyclic arrangement.



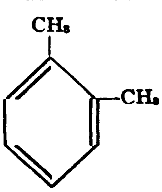
Benzene

The organic chemist uses

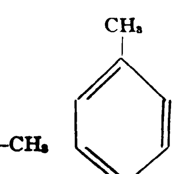


as a symbol for benzene.

The hydrogen atoms in benzene are readily replaced by other groups, and this substitution is the most important reaction of the aromatic compounds. Benzene is a colorless liquid with an aromatic odor. It is the first member of the benzene series. Toluene, the second member, has the following structure:

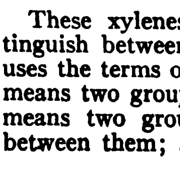


or

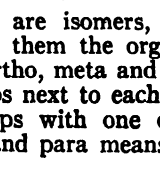


Toluene

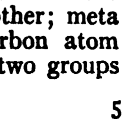
Other important members obtained from crude coal tar are the xylenes.



Orthoxylene

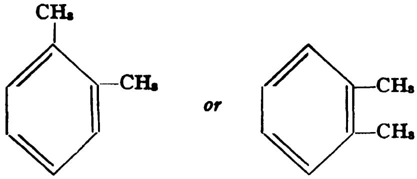


Metaxylene



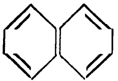
Paraxylene

These xylenes are isomers, and to distinguish between them the organic chemist uses the terms ortho, meta and para. Ortho means two groups next to each other; meta means two groups with one carbon atom between them; and para means two groups opposite each other. Thus orthoxylene may be written:

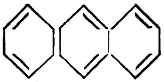


since all positions on the benzene ring are the same.

Two other important aromatic hydrocarbons obtained from distilling coal tar are naphthalene and anthracene. They are white solids and have the characteristic aromatic odor. Naphthalene is used for moth balls and moth flakes. The structures of these two compounds are more complex and their main importance is in the synthesis of coal-tar dyes.



Naphthalene



Anthracene

Before the middle of the nineteenth century all the dyes known came from plants, roots or other natural substances. In 1856 an English chemist, William Henry Perkin, who was only eighteen years old at the time, accidentally discovered the first man-made dye. He was trying to synthesize quinine. He had oxidized analine and had obtained a beautiful violet color which dyed wool and silk. He called this dye "mauve." From this accidental discovery has grown the coal-tar dye industry. As the organic chemist established the structure of a dye and the mechanisms of its reactions, better and cheaper dyes soon followed. Indigo, one of the oldest dyes, was formerly made from the tropical indigo plant, but following the establishment of its structure by Baeyer, natural indigo was soon replaced by the cheaper and purer synthetic indigo. Nearly all the natural dyes have been supplanted by synthetic dyes which have a brilliancy of color and myriads of shades never found in natural dyes. The chemistry of dyestuffs is very complicated and many of the reactions that are in use are not fully understood.

There are other branches of organic chemistry, such as the carbohydrates, terpenes, heterocyclic compounds, amines and compounds containing sulfur. These and other fields are based on the fundamental ideas and classes of carbon compounds that have been presented here. Hydrocarbons, alcohols, organic acids, ketones, aldehydes, esters and aromatic compounds are the units from which are fashioned most of the organic products that serve industry and the public. By the proper reaction of members of the various homologous series discussed, the organic chemist is able to build complex molecules rivaling any found in nature. It is literally true that from coal, air and water the organic chemist can make a bewildering array of carbon compounds. Although the advancement of organic chemistry has been astonishingly rapid during the past fifty years, it must not be assumed that the age of discovery in organic chemistry is past. Sulfa drugs were unknown before 1935, and the silicones, which give promise of being an achievement as important as synthetic rubber or aviation gasoline, were developed within the past few years. We have just established a beachhead in organic chemistry, and the horizons are unlimited.

By Robert W. Levin.

THE NEXT STORY OF SCIENCE IS ON PAGE 6079.

CHEMISTRY TERMS USED IN THIS ARTICLE

Acid—(1) inorganic: a compound of hydrogen and a non-metal other than carbon; or hydrogen and an acid radical, which reacts with metals to form salts; the hydrogen is replaced by the metal.

(2) organic: a compound of carbon containing at least one carboxyl group (COOH); in reactions with metals, the hydrogen atom is replaced by the metal, with formation of salts; other reactions may see the hydrogen replaced by an alkyl radical, with the formation of esters.

Alcohols—a general term for hydrocarbon compounds containing a hydroxyl group in place of a hydrogen atom.

Aldehydes—a group of organic compounds located between acids and alcohols; the alcohol loses hydrogen to become the aldehyde, and this in turn becomes an acid with addition of oxygen. The aldehydes contain the CHO group, with a valence of one.

Alkane—a member of the methane series of saturated hydrocarbons; a paraffin.

Alkene—same as olefin.

Alkyl—a characteristic group, of general formula C_nH_{2n+1}, derived from an aliphatic hydrocarbon by removal of one hydrogen atom; it has a valence of one.

Anesthetic—a substance used to produce a loss of feeling, particularly to touch.

Aromatic compounds—organic compounds derived from benzene or characterized by the presence of one or more benzene rings.

Benzene—the characteristic compound of the aromatic family; a liquid hydrocarbon with the formula C_6H_6.

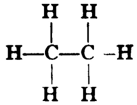
Bond—see *Valence bond.*

Carbonyl group—carbon monoxide (CO) when it acts as a radical.

Carboxyl group—the characteristic group of organic acids, COOH; the valence is one.

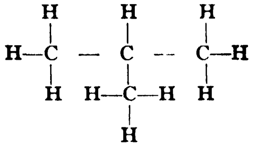
Catalyst—a substance which changes the speed of a chemical reaction but is not itself affected by the reaction.

Chain (aliphatic) compounds — chemical compounds containing carbon atoms arranged in chain-like formation. The chains may be straight-line or branched. For example:



$$\begin{array}{cccc} & H & H & \\ & | & | & \\ H- & C- & C & -H \\ & | & | & \\ & H & H & \end{array}$$

Ethane, C_2H_6, straight chain



Butane, C_4H_{10}, branched chain

Coal tar—a general name used to describe some of the dark, oily liquid by-products obtained in the manufacture of coke or coal-gas by distillation of bituminous coal. It is made up largely of aromatic hydrocarbons.

Cracking—a process of manufacturing gasoline; breakdown of hydrocarbons with great heat.

Cyclic (ring) compounds—see *Ring compounds.*

Denatured alcohol—ethyl alcohol treated by addition of strong-smelling substances (usually methyl alcohol) to serve as a warning that it is poison.

Distillation—the process whereby gas or vapor is driven off from liquids or solids, and then condensed; separating the different parts of a complex substance by heating and condensing, in accordance with different boiling points.

Enzyme—a catalyst produced by nature in living cells, as in plants.

Esters—a family of organic compounds (similar to salts in inorganic chemistry) which are considered formed by the replacement of the hydrogen in an acid with an alkyl radical.

Ethers—a family of organic compounds formed from alcohols by replacement of the hydrogen of the hydroxyl group with a hydrocarbon radical.

Ethyl—the hydrocarbon radical CH_3CH_2 (or C_2H_5) with a valence of one.

Fermentation—a process whereby organic substances are broken down slowly, sometimes by living organisms such as yeast.

Glyceride—an ester of glycerin; soap is composed of different mixtures of glycerides.

Glycerin—a sweet, sirupy alcohol ($C_3H_5(OH)_3$) with three hydroxyl groups; used extensively in the manufacture of explosives.

Glycerol—same as glycerin.

Homologous series—a family of organic compounds, each member of which has the same general formula and similar chemical properties.

Hydrocarbons—a name for compounds containing only hydrogen and carbon.

Hydroxyl group—an oxygen atom and a hydrogen atom linked together (OH), with a valence of one.

Isomer—a compound having the same formula and the same molecular weight as another compound, but having a different arrangement of atoms and different properties.

Ketones—a group of organic compounds containing the carbonyl group (CO) doubly united with carbon, as with two hydrocarbon radicals.

Litmus—a dye, frequently used to treat paper for use as an indicator; an acid will turn blue litmus red and a base will turn red litmus blue.

Methyl—the hydrocarbon radical CH_3, with a valence of one.

Novocain—a widely used local anesthetic.

Olefins—a homologous series of unsaturated hydrocarbons (of the ethylene series), the members of which combine easily with chlorine (bromine, fluorine, etc,) to form oily liquids.

Organic acids—a group of carbon compounds with the properties of weak acids. They will turn blue litmus red.

Organic chemistry—the chemistry of carbon compounds. It is the more complicated of the two divisions of chemistry—inorganic and organic. Originally it was the name given to the chemistry of living substances.

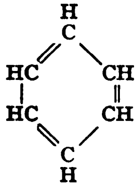
Oxidation—union of a substance with oxygen.

Paraffins—a series of saturated hydrocarbons; the methane series; alkanes.

Polymers—two or more compounds whose molecules contain the same atoms in the same proportions, but not the same numbers. For example, acetylene, C_2H_2, and benzene, C_6H_6.

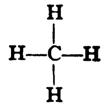
Radical—a group of atoms which behave as one atom, passing through a chemical reaction unchanged.

Ring (cyclic) compounds—chemical compounds containing carbon atoms arranged in circular formation. For example, benzene, C_6H_6.



Saturated hydrocarbon—a hydrocarbon in which all carbon atoms are joined together by only one valence bond.

Structural formula—a short compact way of showing the elements in a compound, the numbers of atoms of each and the manner in which the elements are linked together. It differs from an ordinary chemical formula in providing this last feature, the picture-story of how the components fit together. For example, methane (CH_4):



$$\begin{array}{c} H \\ | \\ H—C—H \\ | \\ H \end{array}$$

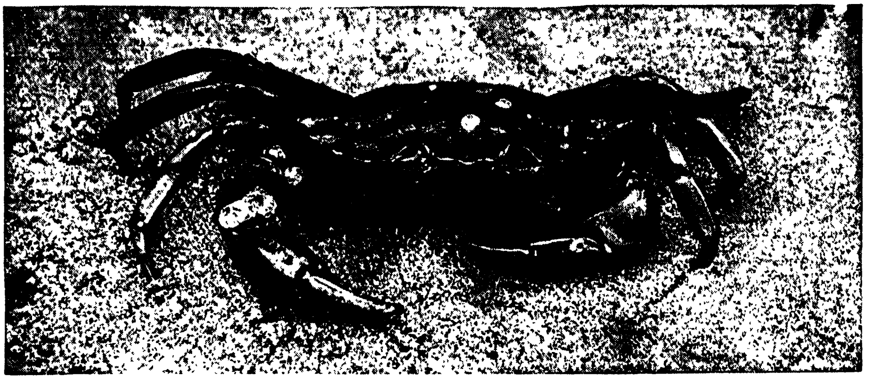
Synthesis—the process of uniting elements or simple compounds in order to make a more complex compound. For example, synthesis of water by joining hydrogen and oxygen.

Unsaturated hydrocarbon—a hydrocarbon with two or three valence bonds, therefore capable of adding other atoms.

Valence—the number of links or bonds an atom (or group of atoms) has, with which to attach itself to other atoms.

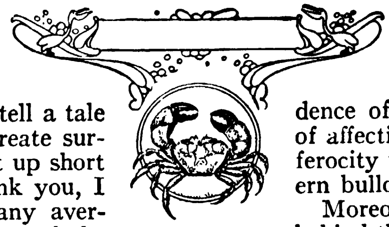
Vulcanizing — the process of chemically treating pure rubber (usually by burning with a quantity of sulfur) to improve its useful properities. The rubber used in automobile tires is vulcanized.

Xylenes—isomeric, oily hydrocarbons, found in coal tar and petroleum.



The Shore Crab.

CRABS, LOBSTERS AND THEIR KIN



AN unpleasant everyday experience is that which comes to us all when we begin to tell a tale which we hope will create surprise, and are brought up short by the remark, "Thank you, I have heard it." In any average company the story of the crabs, lobsters, and the strange little folk to which they are nearly allied in sea and on land, is proof against such disappointment. The facts are so strange that, were they not established truth, they would be received as the fictions of a jester.

How amusing it would sound, for example, if a comedian appeared on the stage with his hand bound up, declaring that he had been bitten by a crab while up a tree bird-nesting! And what a romancer we should think the man who assured us he had been gnawed and maimed by crabs when exploring a mountain height; or that his house had been damaged by myriads of crabs marching right through and over it!

Such things have happened. The old animal fables which our ancestors believed for centuries seem ludicrous to us now, but the facts about crabs and their kindred are almost as unbelievable as anything the old legends said. There are no backbones here, no spinal cords; but we find brain, highly organized nervous tissue, decided evidence of complicated instincts, of affection, of the courage and ferocity we impute to the modern bulldog.

Moreover, there is a history behind the group which inspires a touch of awe. Its members are so immensely ancient. We find their remains in the earliest rocks, and to-day the earth is full of them—more than ten thousand living species, differing widely in size, color, appearance and habits.

We call them Crustaceans, which means "having a crust," for most of them are covered with armor, an outside skeleton, so to speak. They inhabit both salt and fresh water, and some species spend most of their lives on land. The class includes crabs, lobsters, crayfish, shrimps, prawns, sand-hoppers, wood-lice and water-fleas, besides many tiny forms found in the seas and great lakes upon which fishes feed.

The body of a crustacean is made up of a number of segments, and to these segments are attached the legs, the parts which compose the mouth, and the appendages which resemble short claws rather than legs. In many of the species the eyes are raised on stalks and can be moved about like lamps on a flexible arm, but there are others where the eyes are not raised, or, if stalked, are not movable. The mouth is, of course, different from that of a mammal or of any other backboned animal, for in the crabs we have an organ made up of three pairs of jaws, mandibles and maxillæ, which are simply modified limbs.

QUAINT LITTLE LIMBS WHICH HELP THE CRAB TO BREATHE

Such a mouth cannot seize its prey like the carnivorous mammal, but it must be fed and stuffed by the powerful pincers. But, for all that, it is efficient for the work it has to do. Breathing is by gills, but there are wonderful modifications in species which live mainly ashore. Small appendages near the mouth are kept in constant motion in order to secure a regular current of fresh water for the gills. There are special senses, too, in these quaint-looking little limbs.

With these the crab feels and smells. Wonderful that all these offices should be discharged by limbs inclosed in a hard shell. That shell, by the way, is not like the shell of a periwinkle or an oyster, nor does it match the horn of a bison or the bone of a deer's antlers. It is somewhat like horn, a special development of that wonderful substance, chitin, which affords a covering of mail to insects, and even lines their interior.

The crab is not born with this coat of mail. It begins its career in an egg attached to the limbs of its mother, and when hatched is a speck of life inclosed in a tough little membrane. We should never dream, until instructed, that the baby crab is a crab at all, so completely unlike the adult form is it, with a streaming long "beak," a sort of cap over its back, and an eye out of all proportion to the diminutive body.

If it escapes the peril of other crabs and the fishes and sea birds, our little crab slowly comes into possession of its first shell. That has to be changed repeatedly, much more often than the skin of a caterpillar is changed.

HOW THE CRAB WITHDRAWS FROM ITS COAT OF MAIL

For, like the caterpillar, the crab cannot grow without exchanging its outer covering for a new one. When the shell is fully filled, the little crab finds its mail split down the back. Tightly fitted in as he is at every joint, he withdraws each leg in turn from the shell, like a boy taking off his shoes. Then he liberates the body, one half at a time, and is a helpless little fellow in danger lest some hungry enemy may come up and find him a tender, tempting mouthful. The crab must lurk in secret places till he is newly mailed and fit to face the world and its dangers. Very poorly he must feel at such times, for not only does his entire shell come off, but he even molts the coats of his stomach.

We must suppose the crab's sense of smell to be acute, for, unlike the lobster, which likes its food "high," the crab will take nothing but fresh meat, unless sorely pressed. Therefore, as its watery home must be rather gloomy, we take it that its "nose" must be very sensitive to guide it to the bait to which it scurries. It will eat fresh meat; it will catch and eat fish.

One of the crabs commonest to our shores is the Green Shore Crab, but many of us know rocky pools and sandy bottoms which are inhabited by edible Rock Crabs or Blue Crabs. One remembers testing the appetite of an anemone; the creature swallowed eleven little edible crabs as big as quarters at a single meal!

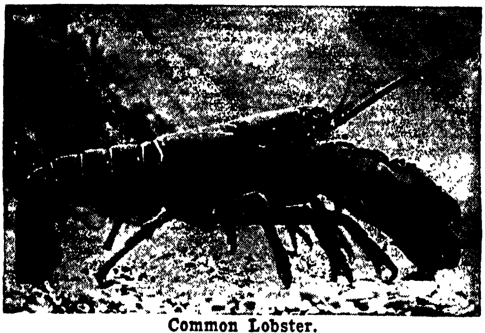
Green Crabs and Rock Crabs are nothing in the way of swimmers, like the Blue Crab; they walk and crawl, and few of us realize how wonderfully agile they are. Like little marine life-guardsmen with their cuirasses on, they seem incapable of anything but the stiffest motion. But when they are cornered in shallow water they will dodge sidewise like lightning as one attempts to grasp them.

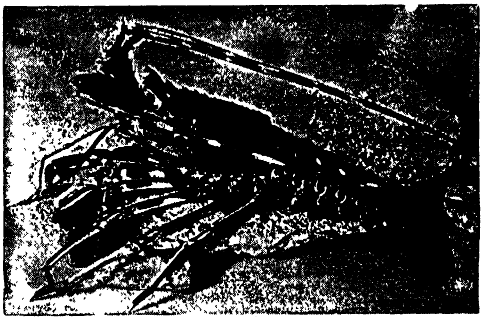
HOW A LITTLE HERMIT SOLVES ITS HOUSING PROBLEM

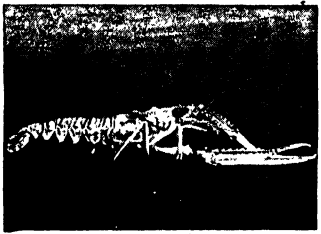
We must not expect feats of this sort from our Hermit Crabs, for they have to carry with them a burden not their own. They are born with the back part of their bodies quite defenseless, though the fore part has its mail, and the claws are as strong as any other crab's. They fear to be pinched in halves, so they have to hunt for homes.

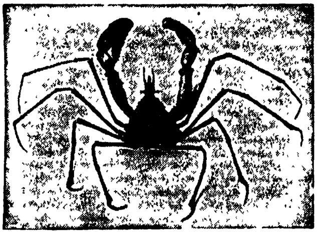
Whelk shells are generally most desired. They prefer an empty one, but, driven to an extremity, they will attack the owner, tear it to pieces, and then take possession of the liberated shell. Hermit crabs have their housing problems as permanent and perplexing as our own.

A GROUP OF LITTLE ARMORED CREATURES

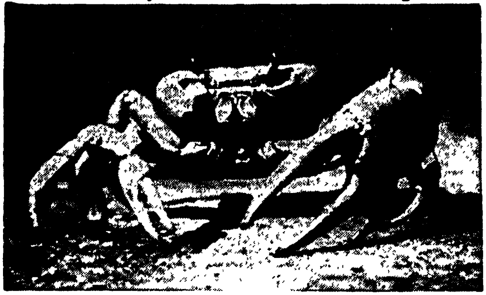

Common Lobster.

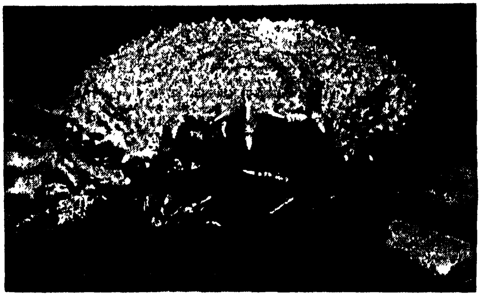

Spiny Lobster.


Norway Lobster.


Long-beaked Spider Crab.

Common Shrimp.

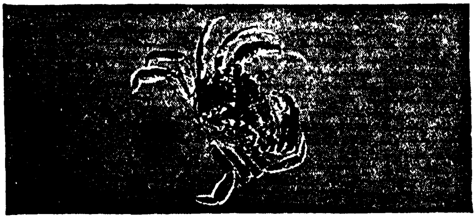

Land Crab.

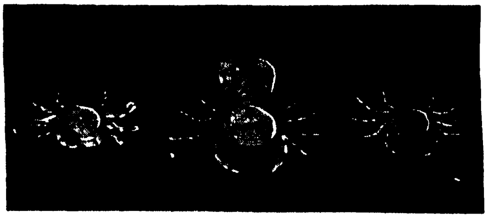

A Giant Spider Crab.

Coconut Crab.

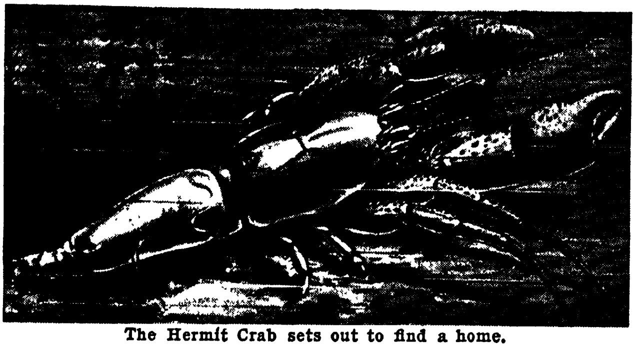
Hermit Crab.

Edible Blue Crab.


Common Green Crab.


Three little Pea Crabs.

The pictures on these pages are by Messrs. S. C. Johnson, E. Step and the American Museum of Natural History.



The Hermit Crab sets out to find a home.

He discovers an empty shell and crawls into it—backward.

Growing too big for his house, the crab fights another crab for the possession of a larger shell.

Once in possession of the borrowed home, they insert their tails, which curl around and fit into the whorls of the fortress, while some of their foot-like appendages fasten like pincers to the walls. The hermit in his shell must have an anemone on it, and the anemone is willing. With the hermit half in and half out, and an anemone mounted on top, together they go roaming in search of food.

PARTNERSHIP OF ANEMONE AND HERMIT CRAB

The anemone stings the enemy of the hermit; the hermit is a pack-horse carrying the anemone to food. It is one of the most marvelous partnerships in the wilds. An anemone is one of the lowest of animals, yet it has this extraordinary understanding with the hermit crab. If we wish to dislodge an anemone from a shell, we must tear the lovely little monster to pieces; but when the crab has grown and must find a larger shell, he dismounts the anemone, takes it with him, and mounts it on the new one. How can we account for such agreements between creatures so low in the scale of existence?

Crabs are camouflage-artists. Some of them take sponges instead of anemones for partners; some rob the sea squirt of his tunic and wrap up in that; some, like the spider crabs of our deeper waters, bedeck themselves with seaweed so that they cannot be suspected of being crabs at all.

They scissor-off cuttings of the weed or of sponge, plant them on their shells, and the cuttings grow where they have been placed, and a moving garden of weed masks the crab within. Having noted that some of our common crabs are crawlers rather than swimmers, we must remember that there are crabs which swim powerfully. The so-called blue crabs are of this group, and swim with their oar-like feet. We have several species of swimmers in American waters, but the common edible Blue Crab of our markets and the mottled Lady Crab are the most common.

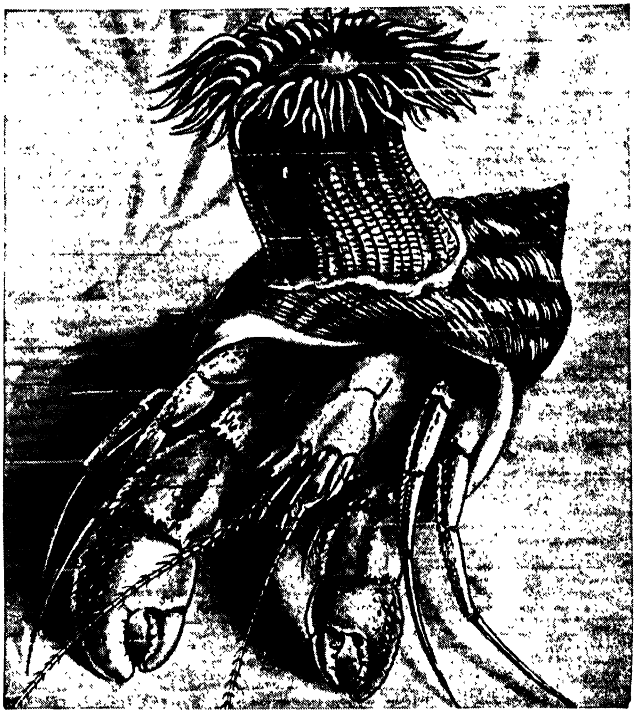
Our waters contain some notable species in the spider-like Slender-beaked Crab, the great Thornback Spider Crab, and minute Pea Crabs which, instead of carrying about anemones or sponges or seaweed, take up their residence within the shells of our common bivalves, living safely in an animate fortress whose food they share.

But let us go into the tropics and take a look at the land crabs. We come to creatures which must still go down to the sea to lay their eggs as frogs must go back to pond and ditch for the like purpose, but they themselves, like those amphibians, drown if confined to the water. One which lives on the verge of the sea burrows into the sand; then, having roughly made its hole, it ejects a strong stream of water from its gills, so clearing a passage for breathing, and is content.

Other crabs go miles away from the sea. Some of them are best known to us by the famous Calling Crab, a title coming from the fact that the crab has one of its foremost claws hugely developed and carries it high and forward when running in such a manner as to suggest to onlookers that it is beckoning someone.

CRABS WHICH PICK UP A HOME AND CARRY IT

These crabs live ashore except for the egg-laying


A Sea-anemone shares the life of the crab.

Changing his home, the crab takes his lodger with him.

The crab establishes the anemone on the new house.

Shells and sponges out for a walk on the seashore.

period. Congregating in swarms, they make great burrows in the sand, like rabbits, combining their efforts with intelligence and art. Experience teaches us not to look for our crabs far from sea, but in the tropics there are hermit crabs which take up their homes and walk far inland. They carry with them large turbo shells. Travelers have found these shells, some empty, some containing the hermits which transported them, a thousand feet up a mountainside, and one severely bit a naturalist who sought to gather something high up in a tree.

Then there are land crabs which crawl about dry docks and do not go to sea—the *Grapsus strigosus,* a little horror, first given its due place by the naturalists of the Challenger expedition. While the party was fishing and bird-hunting on St. Paul's rocks they found themselves surrounded by swarms of crabs, which stole the bait and carried off the fish as they lay new-drawn from the waters.

That was not the worst. Nesting terns had been driven from their young in order that these might be examined, so a big old crab waddled into a nest and seized and carried off a plump young tern to devour it alive at leisure. On Pitti Island, in the Indian Ocean, the traveler tells us, the ground is thick with the remains of young terns, some reduced to clean-picked skeletons, all murdered by crabs. Other crabs regularly raid rabbit warrens, and still others banquet on coconuts. The palm-hunters are usually known as robber crabs.

THE ROBBER THAT CLIMBS UP A TREE IN SEARCH OF FOOD

It had long been known that the Robber Crabs fed on coconuts, but that they climbed the tall palms in pursuit of their booty was deemed a traveler's tale. It is quite true. But how are the crabs to obtain the meat of the nut, inclosed in a very hard shell, and that in a dense husk of fibre? Having climbed his tree and brought down his prize, the crab tears off the fibre strip by strip, then hammers out the "eyes" of the nut with his great claws. Having gained an entry, he inserts his thin hinder claws, and with these drags out the contents of the nut. These robber crabs, big blue fellows, more like lobsters than crabs, can bite a man's finger off, as members of an eclipse expedition in 1922 found out at Christmas Island, in the Indian Ocean.

There are land crabs which, when they make their annual migration to the sea, go as straight as lemmings on the march. They swarm over houses; they swarm through them. The Christmas Islanders found themselves bitten in their beds as the swarming crabs made their pilgrimage to the distant ocean nursery. The whole land is covered with them as they swarm.

Then there are the land crabs of Trinidad. Travelers have told of the swarms of yellow-and-pink crabs, with dead yellow staring eyes, peeping from behind every nook and boulder, as if to say, "You drop down among us and we will do the rest."

Mr. E. F. Knight saw those same crabs of Trinidad, and with two comrades, as they lay in their tents that night, was the victim of a massed assault by the little wretches. They began to gnaw the sleepers as they lay. "They would have devoured us had we not awoke; as it was, they did nibble holes in our clothes."

THE GIANT CRAB WHICH USED ITS CLAWS AS A FORK

Nothing more grim has ever come out of Trinidad than Mr. Knight's picture of these crabs, which, as the three adventurers landed and cooked their evening meal of fish, swarmed in multitudes down the mountainside. They were fearful as the firelight fell on their yellow faces fixed in a horrid grin. "We threw them lumps of fish which they devoured with crab-like slowness, yet perseverance."

> A huge beast (continues Mr. Knight) was standing a yard from me; I gave him a portion of fish and watched him. He looked me straight in the face with his outstarting eyes, and proceeded with his two front claws to tear up his food, bringing it to his mouth as with a fork. But all the while he never looked at what he was doing; his face was fixed in one position, staring at me. And when I looked round, lo, there were half a dozen others all steadily feeding, but with immovable heads turned to me with that fixed basilisk stare. It was indeed horrible, the effect nightmarish in the extreme.

After all their feed of fish, it was these same monsters that attacked the sleepers as they lay in their tent that night.

THE LOBSTER HAS NO SUCH HABITS AS THESE

The Lobster is guiltless of all such charges as these, for, though his claws are prodigious in size and power, no lobster does such things. All the ingenious men, says Charles Kingsley, all the scientific men, and all the fanciful men in the world could not invent anything so curious and so ridiculous as a lobster.

There are many structural differences between the lobster and the crab, though their relationship is as plain as their differences. The lobster is long-tailed; the crab short-tailed. In the lobster the tail is a powerful organ of propulsion. The lobster is commonly supposed to use the tail only to project itself backward, but the organ drives the creature forward as swiftly as rearward.

BABY LOBSTERS ARE HATCHED AND LEFT TO FEND FOR THEMSELVES

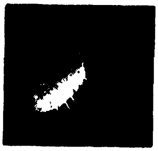
To that broad tail the eggs are attached, the berries, as they are called. From these the little ones emerge, and though about the size of mosquitoes, are at once dispersed and rise to the surface of the ocean, where they remain till after their fourth molt, when they sink to the sea-floor to become bottom-dwellers.

In life the lobster is a greenish blue; boiled, its coat of mail turns a brilliant scarlet. They are caught in traps called lobster pots, attracted by a bait of fish or strong-smelling flesh. They fight among themselves in the pots and bite one another's claws off, so that, if storms delay the visit of the fisherman to his pots, he is certain to find his captures badly maimed when he hauls them up. To prevent such battles en route to market he ties their great pincers together, or else drives pegs into the joints.

But lobsters and crabs do not always wait for battle to lose their claws. The lobster, in a state of panic, casts his claws. The crab can discard an entire leg—several legs, in fact—whereas the lobster's power is limited to the great pincers. But pincers or legs, they can be renewed in the same way as the limbs of an injured starfish. Lobsters are becoming scarce in our waters in spite of all efforts to increase their numbers.

Water-flea.

Sand-hopper.



Wood-louse.

A ship's Barnacle inside its shell.

THE CRAYFISH, WHICH LIVE IN FRESH WATER

Crayfish (often called crawfish in some sections) are the fresh-water representatives of the family. They resemble the lobster in outline, though not in color, and lack the huge fore claws. They are in many a canal and river which we do not suspect, for they come out to feed only at night, lurking by day under stones or in holes in the banks.

When the sun is down, forth come the crayfish in quest of worms, insects, small frogs, fish and vegetation. They obviously hunt by scent, for when men go out to catch them, they bait their hooped nets with a dead fish which is decidedly strong. The net is a rough-and-ready contrivance modeled after the shape of an eel trap.

The crayfish is not prolific like the lobster, which lays as many as 100,000 eggs a season, while the crayfish's eggs may number 200; but there may be only a single one, and it takes five years at least for one of the creatures to reach maturity, though after that they may live another fifteen years or so.

In winter they are sluggish, hidden in some recess in the bank, with claws outstretched to seize unsuspecting prey. But the dead season is a busy one for the mother, as it is then that she lays her eggs so that they may mature and be ready for hatching as spring brings warmth to the waters of the crayfish's home.

Country boys find the holes of the crayfish in low ground by the little rings of earth brought up and arrayed in a circle around the hole. These holes go down to the water-level, and the crayfish remain hidden during the daytime. On the Mississippi and on other rivers which have levees or banks to keep the water from spreading over the land, crayfish often do much damage by opening passages for water. The flowing water makes these larger, and the whole bank may be swept away unless the hole is discovered at once. They sometimes injure the banks of canals in the same way.

THE MANY SPECIES OF SHRIMPS AND PRAWNS

Next in the order come the shrimps and prawns, active swimmers, whose powerful tails impart a sort of leaping motion through the water. Both match their surroundings, either by resembling the ground over which they swim, or being almost transparent, or even changing colors to suit environment. Shrimps are common in fresh water, but we draw our supplies from the seas—supplies so great as completely to defeat all attempts at calculation in numbers.

The Prawns, which are larger, keep farther out from the shore than the shrimps, but both have representatives down in the oozy, unlighted abysses, and there, three thousand feet deep in the Indian Ocean, various species of prawns have been discovered endowed with the art of light-making by means of lovely phosphorescent lamps fashioned from certain glands in their antennæ and along the sides of the body.

Shrimps convert garbage into wholesome food as a vine converts manure and soil into grapes. Extraordinary forms are found in their family, some like skeletons, some with long necks with huge eyes mounted on far-reaching stalks, some with great lobster-like pincers, some fashioned like the praying insect and catching prey with claws of the true mantis type.

Most of the shrimps we eat come from southern waters, where the industry is important, and many are preserved in tin or glass. On the Pacific coast many of one species are dried and sent to China, where they are highly prized.

THE WOOD-LOUSE WHICH CURLS ITSELF UP IN A BALL

We pass on to Wood-lice which, although they are true land creatures, must have moisture, whether they are eating up rotting wood or devouring our maidenhair ferns or tomato plants in the greenhouse. To speak of their eating tomato plants is not an exaggeration. When the tender seedlings are first planted out it is no uncommon thing for a wood-louse to cut down the entire plant as neatly as a woodman cuts down a tree.

As we all know, there are wood-lice which do not curl up and wood-lice which do. The species which rolls itself into a ball is called the Pill Wood-louse. All wood-lice in the wilds turn rubbish and decay to the support of life; but in well-tended gardens and conservatories they are a scourge to the cultivator, and most difficult to eradicate.

We go down to the sea again, to make mention of near allies in the Sand-hoppers. In the sand, under seaweed and other gifts of the sea, these little scavengers swarm. Practically anything organic is food to them. They do not invade our homes and gardens, but eat and eat, day and night, what would tend to make the shore unsavory. Great leapers, they are themselves food for crabs and shore birds. They are good friends to us, though very alarming to nervous people.

THE TINY CREATURES THAT KEEP THE WATER PURE

They are numerous enough, but their fresh-water allies, the Water-fleas, are like the sands of the shore. There are many species of them inclosed in double-shelled defenses, and their life-history is full of interest. Here we can but give them credit for purifying the water of decaying animal matter and for devouring masses of minute vegetable growths.

Omitting many other forms, we must note the Barnacles as belonging to our present company. The barnacle, which is a member of the group of animals technically known as stalked *Cirripedia,* undergoes many changes in the course of its career, finally anchoring itself by its head to ship, floating timber, or other point of vantage, and gaining a living by kicking its food into its mouth with its curious curved legs. The creature is of interest to us all from its habit of clinging to ships in such numbers as to slow down their pace through the water and making it necessary to send them into dry dock.

We must leave this interesting class without mentioning dozens of strange creatures, such as the Giant Crab of Japan, which is more than a foot across, with legs which sometimes are from fifteen to eighteen feet from tip to tip. Then there is the Opossum Shrimp, so called because it carries its eggs in pouches between the legs. The smaller forms which live in the sands are equally interesting.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 6011.

New York City Board of Education

Can a Brain Ever Get Filled Up?

LET us put the question in other words: Can a brain become so filled with knowledge that it can remember no more? Can it be so full that new facts can not be packed into it without displacing old ones? This question, no matter how we word it, seems to assume that the brain is the same thing as the mind.

That is not true. The brain itself is a complex organ, made of tissue just as the rest of the body is. The brain controls bodily movements, and it is also concerned with the senses—seeing, smelling, touching, hearing and tasting. All the knowledge that we have first comes to us through these pathways. The mind, however, is not a physical thing; it can be neither seen nor weighed. It is the part of each human being with which he remembers and thinks, feels love or hate, joy or grief. Nevertheless, it is through the brain that the mind works, and we could not have a mind unless we first had a brain to gather up all the sense impressions. At the same time, we know that no activity of the mind takes place without activity somewhere in the cells and fibers of the brain and nervous system.

Every time that we remember a fact, an idea or anything else, a deeper track is worn along the same passage in nerves and brain that was affected by the original impression of the fact or idea. Perhaps this is best understood by thinking of a telephone message—a long-distance one, needing several connections. The difference is that when we remember we are, consciously or unconsciously, getting a series of connections that we got once (or many times) in the past.

Unless the brain becomes diseased or tired from overwork or age, it can go on making these connections, and repeating them. In general, the more we exercise our memories the better they are. Some people, to be sure, remember more clearly and more easily than

New York Infirmary, photo by Paul Parker

others. Some people remember sounds especially well, others remember sights, others remember words or people or numbers.

The answer to your question is therefore: No, a brain doesn't get filled up any more than a telephone wire gets filled up with messages at the end of a busy day.

WHY DO WE NOT LAUGH WHEN WE TICKLE OURSELVES?

The laugh that comes when someone tickles us is a reflex action, an action that is automatic and has nothing to do with our will. It is really a cry of distress, begging the person to stop tickling our sensitive skin. When we tickle ourselves, we are in no distress, we are not at the mercy of anyone else, we can stop any time we wish.

WHY IS YAWNING INFECTIOUS?

A yawn is a very deep breath. It depends, as a rule, on the fact that from one cause or another our breathing, or our intake of oxygen, has fallen below what is needed. The yawn is an attempt to make it up. It is a very well-known fact that one human being can affect another by what is called suggestion. One person sees another afraid and himself becomes afraid. If everyone around us is laughing and happy, we are likely to laugh and feel happy; or if they are all miserable, we become miserable, too. And so yawning is more powerfully conveyed by suggestion—is infectious, as we say—than almost anything else, because it happens to deal with the most urgent need of all life, which is to breathe. Generally, however, people are infected with the desire to yawn only when they themselves are sleepy or tired, or are not getting enough oxygen.

WHY DOES MY FACE TURN WHITE WHEN I AM FRIGHTENED?

The skin of our faces has a certain amount of color of its own, but the main part of the color of the face—at any rate, among people with light-colored skins—is the color of the blood shining through the skin. It is the heart that drives the blood through the skin of the face. When a person is frightened the nerves running from his brain to the heart almost stop the heart from beating, so scarcely any blood whatever is sent through the skin of the face, and we see the pale color of almost bloodless skin.

WHAT IS MEANT BY AMNESIA?

Amnesia is the Greek word for forgetfulness. We use it nowadays to mean loss of memory from unusual causes. We know, of course, that some people naturally have poor memories, and that, as a rule, very old people slowly lose theirs. Occasionally apparently healthy people, both men and women, young and old, are picked up in the street, dazed, unable to recall their names or anything else about themselves. Sometimes the lost memory returns, either slowly, or all at once. Sometimes the person must begin over again to learn, like a child. We do not understand amnesia, but we know that it may be caused by shock or nervousness, worry, fright, disease or injury.

A condition sometimes confused with amnesia is aphasia. This is also a Greek word; it means speechlessness. Due to disease or shock, a person may lose, in whole or in part, the power of speech. He understands what he wants to say, and his organs of speech may not be affected, but something has happened on the road between thought and speech. Wrong words are used, or the person actually can not talk. This illness often is caused by nervous fatigue and in such cases it usually responds to rest and treatment.

WHY IS OUR RIGHT HAND STRONGER THAN OUR LEFT?

Most humans are right-handed. The right side of the body is a few ounces heavier, the right foot has a little better balance, the right hand is a little stronger than the left. Curiously enough, it seems to be true that the left side of the brain is more developed among right-handed people, and the right side of the brain is more developed among left-handed people.

Left- or right-handedness is an inherited trait, and shows up clearly by the time a child is five or six years old. Parents are advised not to try to train a left-handed child to become right-handed.

As we grow older, the hand which we use more naturally becomes more skillful than the other, from constant practice.

An archer needs strength in both arms. However, the stronger arm, usually the right one, is used to pull the bowstring back. The bowstring hand must have more dexterity also, as it holds the arrow in place.

PAL

WHERE DOES A THOUGHT COME FROM?

We should always make a point of using the word "thought" in the strict way, meaning the putting together of two ideas. "Tom is good" is a thought. It puts together the idea of Tom and the idea of goodness. We say that there is a relation between Tom and the state of goodness. "Tom is not good" is another thought asserting another kind of relation between Tom and goodness. Many people do not always understand clearly what the words "thought" and "thinking" mean.

This brings us to the answer to our question: Where does a thought come from? It comes from outside ourselves. It comes from seeing, hearing, smelling, tasting, touching or moving through space, or from remembering and putting together things our senses have taken in.

Learning is based upon this truth, even in the cradle. A mother shows the baby a red ball, and says "red." Then she shows

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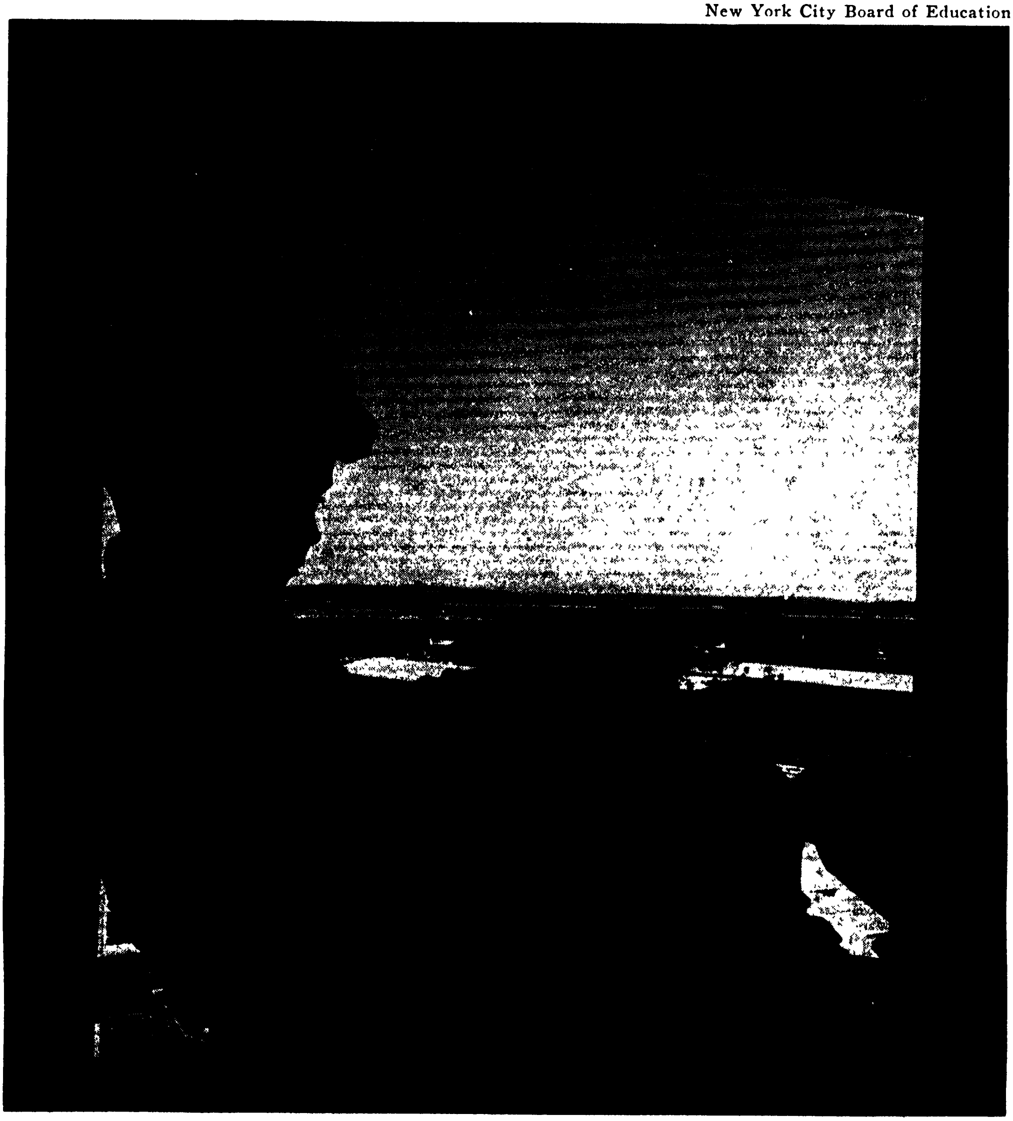


a red picture in a book, a red coat or dress and other red objects. Even a very young child will soon think "Red looks that way."

CAN WE BREAK OURSELVES OF BAD HABITS?

Of course we can. But we must know what we mean when we speak of habits. Breathing and eating might be called habits, and we can not break them, for the very structure of our bodies is dependent on them. But real habits are things learned, and are not essential. As bad habits have been learned, so good habits can be learned to take their places, if a person seriously wishes it.

CAN WE THINK WITHOUT WORDS?

There are some kinds of thinking where the things which are put together or related are not words. Some men, for instance, in doing what is called algebra, can think without using words at all. They can find out, for instance, what this means: $A + B \times A - B$. Or, instead of thinking in words or figures, men can think in lines and angles and curves.

Scientists can think in formulas, without words. Other men can think in musical notes. One of the greatest musicians that ever lived, Beethoven, wrote some of the most marvelous music in the world, which will be listened to as long as men have ears, long after he had become stone-deaf. He could think in notes as easily as you and I can think in words. However, figures, formulas, musical notes and words as well are all symbols; and even the most difficult kind of thinking can not be done without the use of some kind of symbols.

HOW DID MEN LEARN TO TALK?

Anything that expresses to someone else what is going on in our minds is, in a way, a sort of talking. We can tell by a baby's cry a great deal of what it wants and feels. Different kinds of cries have different meanings. That is a sort of language, and men probably learned to talk from just such beginnings, facial expressions, cries and grunts of pain and pleasure.

The simplest words, the first-comers, were probably sounds describing or imitating something. Small children call a dog a "bow-wow," a duck a "quack-quack," a locomotive a "choo-choo." We all use some words of this sort—"buzz," "whirr," "pop" and many others.

Slowly, from such small beginnings, a treasury of words was accumulated, different, of course, in different parts of the world.

Nowadays if we need a new word we invent it, often going back to Latin and Greek for the roots. "Telephone," "vitamin" and "automobile" are invented words of this sort.

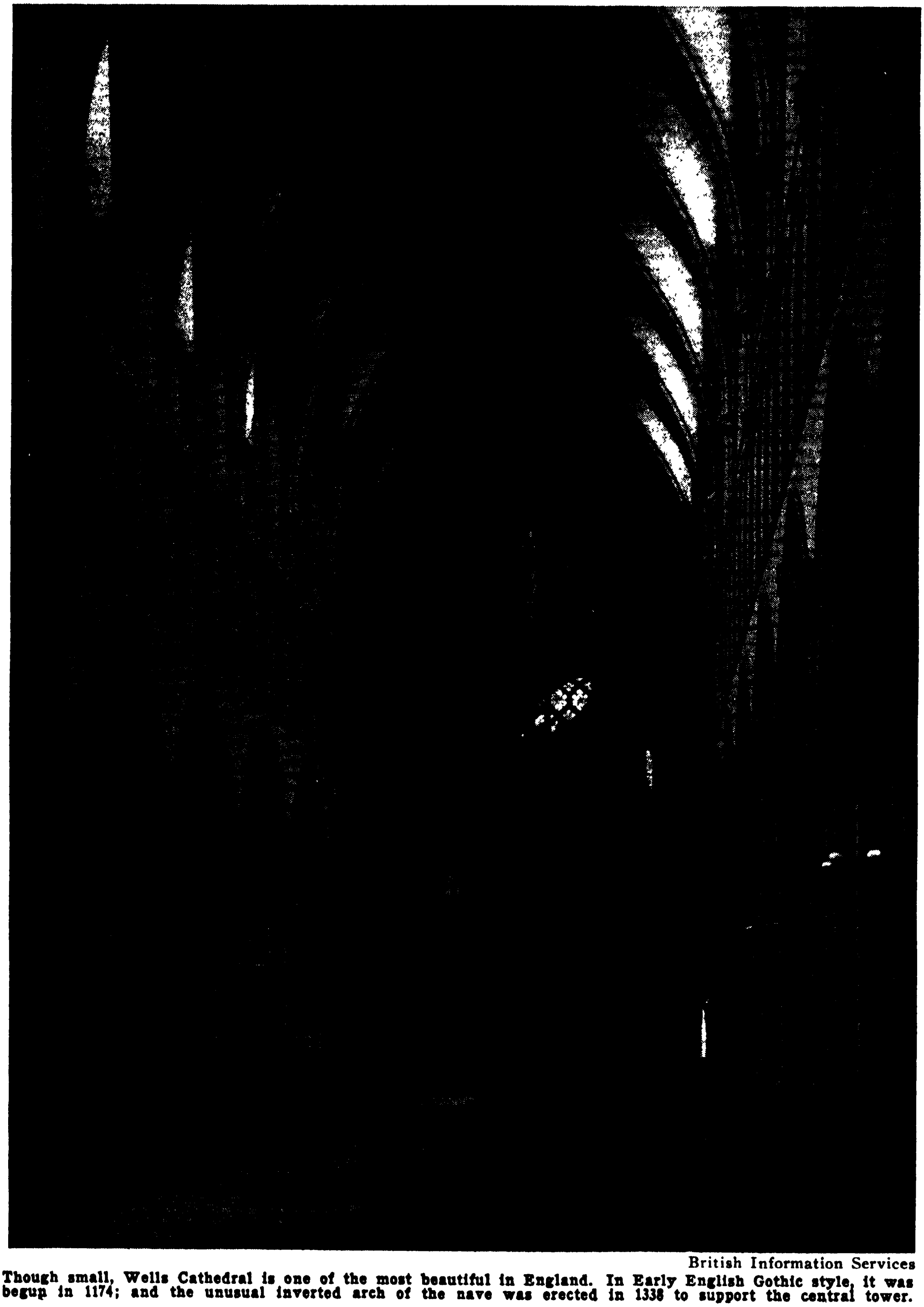
WHY DO WE WORRY?

Most people do not worry so much about the present or the past as about the future. We worry about having to go to the dentist, but when the tooth is actually being drilled we do not worry, though we may hate the pain. Afterwards we do not worry in memory of the pain.

Babies and very small children live only in the present. They do not worry. It is the mark of man, however, "to look before and after," to wonder and fret and fear about what is to come. This power of man to see himself in different situations is one of the less pleasant ways in which we are set apart from other creatures. If our minds are clouded by worry we are unable to think clearly and the right answer to our problems escapes us. We can, and we should, learn to keep worry under control.

THE NEXT WONDER QUESTIONS ARE ON PAGE 6021.

THE LOFTY NAVE OF WELLS CATHEDRAL

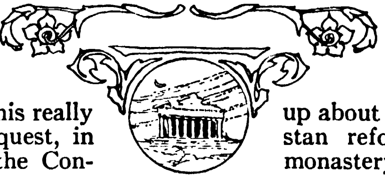


British Information Services

Though small, Wells Cathedral is one of the most beautiful in England. In Early English Gothic style, it was begun in 1174; and the unusual inverted arch of the nave was erected in 1338 to support the central tower.

Wells Cathedral.

GOTHIC ARCHITECTURE IN ENGLAND



THE earliest buildings of any importance in England date from the Norman period. This really began before the Conquest, in the reign of Edward the Confessor, who was educated at the Norman court. Before this time there are a few Saxon buildings of simple style, naturally influenced by the Roman occupation. Of Roman work only ruins now remain: scraps of London Wall, Hadrian's Wall, mosaics, bath-chambers, and so on. But we know there were temples, basilicas and villas in the Roman towns of Britain, just as there were in any other country which those great builders conquered.

Saxon work exists for us now in a number of churches, like those at Worth, Sussex, at Escomb, Durham, St. Lawrence, Bradford-on-Avon and Brixworth in Northamptonshire; and towers like Earls Barton, Northampton and Barton-on-Humber. But there are also many hidden Saxon remains in churches of a later style, and these are often not discovered until there is some reason for laying bare the old foundations.

The first important building of the English Romanesque, or Norman, style was a new church called the West Minster, dedicated to St. Peter, built by the Confessor. There is a tradition that the oldest church reared on this site was a Saxon building set up about 616. In 960 St. Dunstan refounded a Benedictine monastery there. A hundred years later the Confessor began the work of rebuilding and strengthening. He was buried in the church in 1066. We shall presently see how later rulers continued the work he began.

The Normans who settled in England after the conquest by William were, like the rest of their race, an intelligent, powerful people, capable of great mental elasticity, and with a natural feeling for beauty. They were Christian, but none the less fighters; and from their combining a lofty motive with a soldier's skill sprang the chivalry of Norman England and France. From their vigorous Christianity and desire to see some monument of their faith established sprang the lovely churches of the period, built on the same lines as those of Normandy.

The English Channel was never a wide waterway, although we seem to consider it as a great barrier; and in the days when it divided Norman England from Norman France—the days of almost impassable roads and easy sailing—it was a little strait, continually being crossed. Thus into England came more and more of that European influence which had begun when Edward the Confessor, educated at the Norman court, became king. Stonemasons and woodcarvers, craftsmen in metal and different kinds of workmen, came over in considerable numbers, and brought not only their tools, and probably their families, but also their ways of thinking, and such education as the religious architecture of northern France had given them. The men who had planned the great Norman churches continued their work in England.

THE NEW STYLE OF ARCHITECTURE WHICH AROSE IN EUROPE

They loved unbroken masses and semicircular shapes, as we can see from their walls and rounded arches, piers and columns. They disliked a line broken up for a small and pretty effect. But before they had well established their new churches among the greenery, the rivers and fens of England, before five successive Norman rulers had had time to consolidate their power, the spirit of architecture in Europe had changed. Romanesque had given place to Gothic, and the fever, spreading over the Continent, seized England.

But by this time a number of magnificent cathedrals and churches had been set up; and though almost all of them served merely as the core of a later Gothic building, here and there we can see something of the work of the early builders of England. In the cathedrals of Canterbury, Winchester, Rochester, Ely, Hereford, Norwich, St. Albans, Worcester, Oxford, Chichester the touch of Norman builders is to be seen in choir, nave or tower.

They reached their height in Durham Cathedral. This wonderful pile was, of course, added to later, but Time has been kinder to Durham than to many of the cathedrals of that wonderful century following the settlement of the Normans in England. There is nowhere in England a more beautiful sight than the Norman nave of Durham Cathedral, with its fluted and spiraled columns.

THE WONDERFUL CHURCH FOUNDED BY A KING'S JESTER

Peterborough is another great cathedral which is Norman at heart, and the abbeys of Waltham and Tewkesbury point to the same inspiration.

In London there are two particularly fine specimens of these great masters' work, the White Tower with the little chapel of St. John, in the Tower of London, and St. Bartholomew the Great, Smithfield. This church is part of an Augustinian priory which, with the hospital near by, was founded in 1123 by Rahere, court jester in the reign of Henry I.

Rahere was very ill in Rome, and he vowed a vow to God that if his life were spared he would build the finest priory in London next to that of the Benedictine monks at Westminster. Rahere's tomb is in the church (added some three hundred years later), and as we look at it we cannot help feeling glad that this witty courtier was spared to erect such a monument of gratitude as the priory of St. Bartholomew. He fulfilled his vow in a superb style, unstintingly, and the work that he left uncompleted his successor finished.

The church is all that is left of the priory, whose conventual buildings, lying on the south side—cloisters, refectory, chapter house, dormitory—have long been destroyed or have served as foundations to other buildings. And that which is called the church is really only half of it.

THE CHANGES THAT HAVE COME OVER ST. BARTHOLOMEW'S

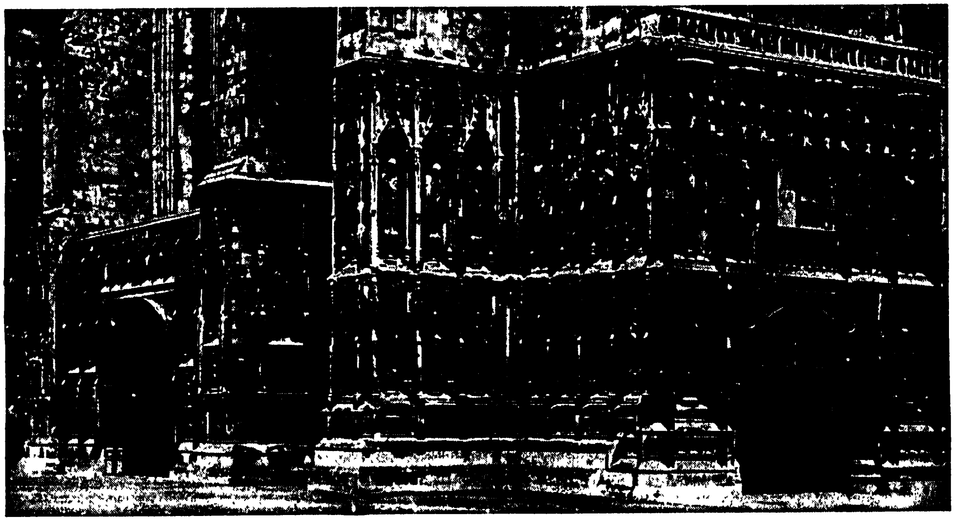
We can get some idea of its original size if we remember that the place where we enter a modern doorway in a seventeenth-century tower was where the transepts crossed the nave. Thus we walk straight into the choir itself, which is larger than many churches, and gives an impression of solemn grandeur, with its massive round columns and semicircular arches. The place where the nave stood lies outside the present church wall, a bare stretch of stones reaching from the door to the pavement of Smithfield.

The long vista of nave and choir, with the lady chapel beyond the apse, ranked like a forest with massive columns, must have been one of the finest things even in those days of beautiful churches. And we are intensely thankful that even a part of this magnificent church remains. It has passed through more than usually troubled days. At one time the north transept was used as a blacksmith's forge. The lady chapel has been a printing-works and, later, a factory. In 1896 it was rebuilt. Such of the conventual

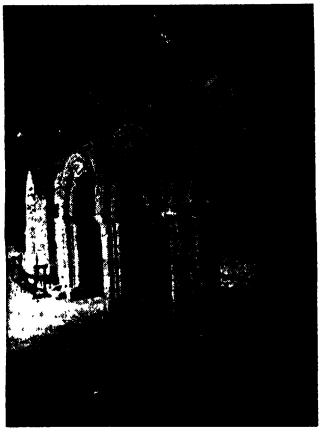
THE SPLENDID CHURCHES OF ENGLAND

The crypt of Canterbury Cathedral.

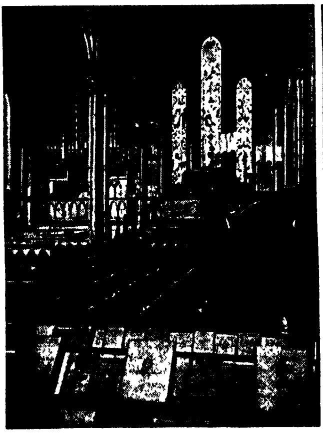
The Galilee chapel in Durham Cathedral.



The south porch and west door of Canterbury Cathedral.



The entrance to the chapter house at Bristol.



The pulpit and organ in Temple Church.

The north aisle of Durham Cathedral.

buildings as are not destroyed are being cleared of added buildings—one of them a stable—and before long the ruins of this unique pile will be able to tell their own historic tale.

There have been additions and alterations in successive centuries, but, mercifully, not to any great extent. A perpendicular clerestory rises above the Norman blindstory, or triforium—the part of the wall that lies above the pillars of the aisle and below the aisle vaulting that supports the roof. A gallery sometimes runs behind the blindstory. It is called "blind" because this part of the wall is marked by rows of arches through which no light comes. And the blindstory is also called the triforium because inside the arches are usually set three other little arches (*tres* means "three," and *fores,* "openings"). The clerestory and blindstory, or triforium, have been very important features of architecture from Norman, or Romanesque, times to our day.

THE ROUND CHURCHES THE CRUSADERS INTRODUCED INTO ENGLAND

A most interesting little side development of Norman architecture was the round church. These builders loved circular lines; hence their "wheel" windows, whereof so few remain. But it is probable that the idea of the round church, which Romanesque workers on the Continent set up in imitation of the circular baptisteries, was introduced into England by travelers and Knights Crusaders who had seen the buildings of Southern Europe, and particularly the Church of the Holy Sepulchre at Jerusalem.

Very few of the circular churches are left. There is St. Sepulchre, Cambridge; one at Northampton; another at Little Maplestead. The most famous is the Temple Church, London. Since early in the fifteenth century the Temple—a large area containing squares, gardens and halls—has been one of the Inns of Court. Before that time it was the headquarters of the Knights Templars, the most chivalrous order of Norman times.

More than once, restorers have been obliged to repair Time's ravages in the Temple. Worst of all are the damages wrought by bombs in World War II. We can only hope that these also may be repaired. The descriptions in this chapter are of the Temple as it was.

The round church of the Knights Templars was consecrated in 1185, at a time when Romanesque was merging into Gothic. Hence it is called Norman transitional. The original apse that carried the choir out from the circular nave has been replaced by a very fine early Gothic choir. The entrance porch and doorway and beautifully carved door are most delightful specimens of Norman skill. Under the gracious round curve we pass into the round church.

Marble monuments of nine Templars fully armed lie in the church in front of the clustered marble shafts that uphold the roof. They lie as if asleep, and are variously posed. Those whose ankles are crossed had been on one Crusade only; those whose knees are crossed went twice; those whose legs are crossed still higher are knights of three Crusades.

It is impossible not to feel the mysterious power of beauty and history together as we stand in the Temple Church, particularly if it should happen that we are there on the afternoon of the last Sunday in the old year when, by long custom, the choristers leave their stalls in the chancel and make a ring in the round church by the sleeping knights, and sing the oldest carols of our Christian faith. The fingermarks of history are plain in the Temple. Two of the stops in the organ were put in by the "infamous" Jeffreys. Outside, in the garden, grew the white roses and red wherefrom the quarreling Yorkists and Lancastrians plucked their badges.

> This brawl to-day,
> Grown to this faction in the Temple garden,
> Shall send between the red rose and the white
> A thousand souls to death and deadly night.

THE SPIRIT OF THE CRUSADERS WHICH HAS GONE FOREVER

But most of all we remember, as we return to the Norman church, that spirit which has gone forever, that mixture of soldiery and religion which was the stamp of Crusading times. Blake must have wandered much in and out of the Temple Church, and seen in his dreams the steel-mailed Templars walk clanging across that beautiful tiled floor, and drunk in the spirit that has made England great before he wrote his lovely Jerusalem:

> Bring me my Bow of burning gold!
> Bring me my Arrows of desire!
> Bring me my Spear! O clouds, unfold!
> Bring me my Chariot of fire!
> I will not cease from Mental Fight,
> Nor shall my Sword sleep in my hand,
> Till we have built Jerusalem
> In England's green and pleasant land.

This round church of many memories is the last creation of any importance to bear the stamp of Norman work in England. Another architecture was growing whose beginnings are difficult to trace.

No one knows exactly why the term Gothic was given to the medieval architecture of Europe, for it had nothing to do with the Goths. It is said that Raphael used the words in describing this "new" architecture that had appeared north of the Alps. In his mouth the term was scornful, for the word Goth was used to denote an uncultured barbarian in contrast with a cultured Roman. Whatever its origin, the term has clung, and in the passing centuries has lost its flavor of reproach.

HOW THE SEAT OF POWER MOVED STEADILY TO THE WEST

We can understand how distasteful the new architecture was to men whose ideas were bound to the old. Prejudice against something new is one of the most enduring traits of human nature. And as Europe owed all she knew of art to Greece and the East, there was something to be said for those who denounced a strange art which was abandoning classical style.

But these men, these worshipers of the old, did not, or would not, realize that the centre of the world's life was moving steadily westward. And as the seat of power changed, architecture changed.

Greece was the home of the rectangular, columned temple. The Romans copied it. The early Christians copied work of Romans and Greeks together in an inverted way, setting rows of columns inside a severe rectangular wall, whereas the Greeks had set rows of columns outside a severe rectangular wall. Thus, as one writer says, the basilican churches were Greek temples set outside in.

Romanesque art was still derived from Greece and Rome, its chief characteristic the round-headed arch. But in the meantime the colonnade, the rows of columns that supported part of the roof, had changed to an arcade—rows of columns whence arches sprang that supported part of the roof.

THE LOFTY IDEALS OF THE BUILDERS OF THE THIRTEENTH CENTURY

So far we may trace the architecture of Europe to Greece. It was on the principle of the arch that the change came. The makers of new buildings, in that wonderful thirteenth century, were dissatisfied with what seemed to them the heavy, gloomy erections of the Romanesque type. The minds and souls of men were charged with lofty ideals, sacred aspirations and a new love of beauty. They wanted to make buildings that would fling themselves heavenward in praise and joy, and be the outward and visible sign of an inward and spiritual grace. Thus they gradually gave up the massive round shapes of Romanesque arches and began throwing up the long, pointed arches that we call Gothic.

The love of this "aspiring" form became a fever. Upon these lighter, more airy buildings, towers and spires were set. And all over Europe an amazing architecture presently rose which had nothing of the repose of the old world's buildings, but stirred with a new life.

In the temples and churches of the East windows had been almost unnecessary, because of the extreme radiance of the atmosphere. The colder and mistier light of northern countries made a certain amount of lighting imperative. The makers of the early cathedrals of Northern Europe seized this chance of a new architectural feature with all the eagerness that marked the period. Windows presently became one of the most important parts of the fabric. The different periods of Gothic work may be determined by their design.

THE FOUR GREAT FEATURES OF GOTHIC ARCHITECTURE

Thus we see three of the four characteristics of Gothic architecture: the pointed arch, the window, the tower, or spire. The fourth, the buttress, is both an interesting development of a Roman feature and an important point of Gothic construction.

The greatest problem in a large building is, as we can understand, the supporting of the roof. If it is supported in the Gothic way, by vaults that spring from arches, there is a great strain on the points of the walls where the arches press. An arch always tends to flatten itself; it thrusts out its ends against the wall or pier into which it is built. When many arches cross and combine to support a roof, the walls need very careful treating. This is part of the problem of "strains," which is very important in an architect's work. If the thrust and strain of supporting arches are not properly met, the roof, or bridge or tunnel, or whatever the arches are carrying, will fall in.

When the Romans set a weight over one of their round arches they strengthened the part of the walls whereon the ends of the arch pressed by an extra thickness. It seemed to them advisable, in their imitation of Greek styles, to use a piece of an order in this way. They made the column part of the wall, attaching it to the masonry at one side, and they gave it a heavy base. This half-column was called a pilaster, and formed a support against the thrust of the arch.

WHY THE BUTTRESS IS SO NECESSARY IN GOTHIC BUILDINGS

In Romanesque times the pilaster became, so to speak, a flat piece of wall fastened on the other wall, sloping outward, for strength's sake, at the base. Presently, so that this greater basic weight should be obtained without making an unpleasant line, the ridge of the wall was shelved in three places. From this grew the buttress of Gothic architecture. The more arches there were, the more windows (set in arches, of course), the greater necessity there was to strengthen the wall. Buttresses grew more and more important, heavier, more frequent. They ran the height of the building, working out very broadly as they descend. And as one of the rules of architecture is that a line shall end properly, they were presently surmounted by pinnacles. So we see that a constructional necessity was the cause of one of the chief features of Gothic architecture. People who have not had time to learn much about this subject are apt to think that buttresses were added, like towers, by way of ornament, and for no other reason.

In addition to the buttress, we have the "flying buttress." This was designed, not for its lovely lines, but for a hard necessity. As the centre aisles of the cathedrals were carried higher, and more and more windows set in the fabric, the arches of this highest part had to be outwardly supported by a flying buttress, which was in turn supported by the ordinary solid buttress. A wall which is nearly all windows has little strength, and, as strength must come in somewhere, the solid buttresses began to step out farther and farther, so to speak, from the building, and became like little towers in themselves. At the same time they were being narrowed so that all the available space between them should be given to windows.

THE GREAT ARTIST WHO PREFERRED THE CLASSICAL STYLE OF BUILDING

The architects of medieval cathedrals naturally became more and more engrossed in this fascinating game of playing tricks with construction. No other architecture of any period or place has produced anything approaching the sheer cleverness, apart from beauty, of Gothic work. It was, as a writer has said, like a body that carried half its bones outside, and still lived. We can quite understand Raphael, who loved the compact mass of classical architecture, with flat roofs and perfect lines, holding up his hands in horror at that architecture of Goths, yonder, north of the Alps.

The Romanesque builders had thought they were advanced men when they broke their long church or cathedral walls by a short nave, and threw out the chevet of the apse. But the Gothic architects could be even prouder of their achievement. Thousands of workmen labored on those medieval cathedrals with tool and chisel. When all the sculpture and carving was done, all the numberless little saints set smiling and happy in their niches, the tale of Christ's life told in glass in the great windows, those medieval cathedrals must have seemed too beautiful to be real. It must have appeared a fantasy, this delicately balanced mass of lovely slender stones and sweeping lines and pointing spires, held together by invisible hands.

THE THREE PERIODS OF GOTHIC ARCHITECTURE IN ENGLAND

By its very nature, Gothic architecture cannot last. It marks a period of development in the Christian Era whose pure spirit can never be recaptured. So that the love we have for medieval buildings is the love of something which may easily be lost, and, once lost, is lost forever.

For three hundred wonderful years cathedrals in France, Germany and England were built in this style, which in itself was constantly changing or developing. In England Gothic architecture is divided roughly into three periods—that of the thirteenth century, called Early English; that of the fourteenth, called Decorated; that of the fifteenth, called Perpendicular. In a great many English buildings these three styles meet, as one century made additions to the work of the century that went before it.

English Gothic architecture is marked by a sobriety and a strength that does not often appear in French Gothic. A Gothic building, to be imposing, must excel in either length or height. The French attained a greater height, and the English a greater length. Although the work was executed on the same principles, the effect of national character came out; so that in time English Gothic became a distinctive architecture of its own.

In time, we say, for at the beginning of Gothic work there was very little difference. England and Normandy were still, practically speaking, one province, divided only by the Channel, and workmen still came and went as from one end of a kingdom to another. One of the most interesting cases of this interchange of labor was that of William of Sens—a little town south of Paris—being summoned to Canterbury in about 1170 to rebuild the cathedral on the lines of that he had just set up in Sens. The French William built the choir and William the Englishman continued the work.

THE DOMINATING FEATURE OF THE EARLY ENGLISH GOTHIC

Early English Gothic was simple, of fine proportions, with lancet-shaped windows which were long and narrow, pointed at the head. This particular shape could be seen not only in the windows, but in the whole structure; arches, doorways, the lines of the roof vaulting, the clerestory and blindstory, all conformed to this delicate and beautiful shape. When we go to London we can see what Early English Gothic was in the choir and lady chapel of Southwark Cathedral (the nave has been restored), the chancel of the Temple Church, the chapel and crypt of Lambeth Palace, and certain parts of Westminster Abbey.

A great many of the provincial cathedrals happily retain something of the Early English spirit. We can find it in the transepts of York Minster, the nave and chapter house of Lincoln Cathedral, the choir and transepts of Rochester Cathedral, the nave, transepts and west front of Wells Cathedral, the choir, transepts and the "Galilee Porch" of Ely Cathedral, and in parts of Southwell Minster, Worcester Cathedral, Beverley Minster, Glasgow Cathedral, Elgin Cathedral.

THE THREE SPIRES THAT TOWER ABOVE THE RIVER AT LICHFIELD

The finest and most complete evidence of what Early English Gothic was is shown at Salisbury and Lincoln.

The little cathedral of Lichfield—one of the smallest in England—also has a peculiar interest as we study this period. The main part is Early English, with an unusually fine west front. Lichfield is the only cathedral in England possessing three spires (added in the fourteenth century), two at the west front and one at the crossing of the nave and transepts. These three graceful points are known as the "Ladies of the Vale."

The simple spire, without any parapet, surmounting a short tower at the crossing was a feature of Early English Gothic. In the later period towers became heavier, and sometimes stood alone, and sometimes were surmounted by spires. The French architects threw up their cathedrals to such an immense height that the structures could not support a heavy tower at the crossing. The central tower remains an English feature of Gothic architecture.

The most beautiful spire in England is that of Salisbury Cathedral. This building is one of England's most precious possessions, a piece of the best Early English Gothic imaginable. Almost all the cathedral as it stands was built during the years 1220 to 1258. The spire, 404 feet high, the loftiest in the country, was added a hundred years later.

THE CATHEDRAL WITH A WINDOW FOR EVERY DAY IN THE YEAR

There is often a rambling look about Gothic cathedrals, as if they grew, rather than were planned. This is absent in Salisbury Cathedral. It is beautifully proportional and held together, line falling upon line, the spire rising triumphantly from their midst. By accident, or curious design, the cathedral is said to contain as many windows as there are days in the year, as many pillars as there are hours, as many doors as there are months.

The interior as well as the exterior is stamped with Old English history. Here are monuments to some of the early bishops and to a great many nobles—some of artistic interest, others memorable because of the dead. Richard Jefferies and Henry Fawcett, the blind Member of Parliament, have memorials here.

Lincoln Cathedral tells us another beautiful tale of old English genius. It rises on a hill above the town, washed by the clear East Country air, throwing bravely up its middle tower as if proud that it is the highest central church tower in England. The measurement of this tower is 271 feet high. The tower planned for the new Liverpool Cathedral is 280 feet. Liverpool Cathedral has been damaged by German bombs, however, and its completion has been put back.

The earliest parts of Lincoln Cathedral, the choir and eastern transepts, were erected in about 1190 by an English architect, a Lincolnshire man. The building went on for over a hundred years, and at the end of that time, in about 1314, the "Angel Choir"—more in the Decorated style than the Early English—was built. The general plan is something like that of Canterbury, but the treatment, the solidity, the gravity are very English, hence the phrase, "National Lincoln."

THE DECORATED SCREEN WALL ON THE FRONT OF LINCOLN CATHEDRAL

The west front of Lincoln Cathedral is of great interest, apart from the lovely work, in that it is a kind of decorated screen wall, and behind it rise the western towers. The screen wall is broken by very beautiful doorways, but this hardly makes up for the way the towers seem to be cut in half and have no base.

These towers, spires and decorations at the western end of Gothic cathedrals grew out of the architects' desire to end the building so as to hide the abrupt finish of the roofs of nave and aisles. If we look at our pictures of various cathedrals, we shall see what a wonderful development this is, always remembering that one of the chief points in architectural design is that line shall be properly stopped—the line in this case being the long length of the cathedral roof.

One of the most wonderful western fronts in Early English Gothic is that of Peterborough Cathedral. Here three immense arches run up the entire height of the building, with a gable on each arch, giving a grandeur and simplicity of line that has no equal. The façade is said to be the finest west front in the world. In this fine cathedral is united most memorable work both of Norman and early Gothic period. Unfortunately, for all their solid, heavy masonry, the Norman builders made poor foundations. If Peterborough Cathedral had not been skillfully underpinned it would have been in ruin before our day.

THE WONDERFUL LANCET-SHAPED WINDOWS OF YORK MINSTER

Another trace of the genius of Early English Gothic is shown in the famous transepts of York Minster. Here, in the northern transept, are The Five Sisters—five immensely long, lancet-shaped windows, side by side, fifty feet high and five feet wide. Some of the finest stained glass in England, made in the fourteenth century, is in this cathedral.

To the fourteenth century belong the west front and nave of York Minster, and here we can see the difference between the Early English and Decorated Gothic. The windows have become larger, and instead of being simple, lancet-shaped lights, are marked by elaborate stone traceries, which act like settings to the jewels of the colored glass. This rich splendor and ornateness, spreading to all details of architecture in stone and wood alike, was the chief note of the Decorated period.

During this time a good many towers were set up on various cathedrals, and the "fancy" spire, rising from a tower base, sometimes many-sided, with parapets and lights and pinnacles appeared. Very fine chapter houses were built. Clerestories, set high in the walls, became more important, and blindstories less important.

It is interesting to note, in passing, that Bristol Cathedral has neither clerestories nor blindstories, the aisles being carried up almost the height of the nave. This cathedral, like those of Bangor, Llandaff, Ripon, St. Albans, Southwark, has been variously restored and added to.

THE FINE CHURCHES THAT WERE LOST IN THE FIRE OF LONDON

The interiors of decorated Gothic buildings were marked by very elaborate roof vaulting, the ribs, or surface ridges, of the vaults making all kinds of geometric designs. To this period belongs the star-shaped vaulting, where the ribs cross each other to make a star.

A fine specimen of Decorated Gothic architecture can be seen in the Chapel of St. Etheldreda, in Ely Place, Holborn, originally the chapel of the Bishop of Ely's palace. Both east and west windows are excellent examples of the work of this period. The Church of the Austin Friars, and St. Helen's, Bishopsgate, also bear the stamp of the fourteenth century. To these years belong the east cloisters of Westminster Abbey.

The builders of this period, which roughly covers the fourteenth century, were employed in many ways in England, adding a chapel or a transept here and a tower there. There was no great line between Early English and Decorated Gothic. Many churches were built which are lost to us through the Great Fire of London in 1666.

The Decorated period touched its height in certain parts of Exeter Cathedral, and the Lady Chapel, Ely. The carved work in stone and wood of Exeter Cathedral is among the finest in England. A great breadth and a wealth of stone tracery mark the windows; details like the minstrels' gallery are especially beautiful. One unique feature at Exeter is the carrying-up of the north and south transepts into twin towers. It is interesting to note that in this cathedral is the second heaviest set of bells in Europe.

The genius of this wonderful fourteenth century in England did not restrict itself to the mere fabric of the building. Cathedrals and churches were frames, so to speak, wherein was set most lavish craft-work of all descriptions in wood and metal. The stoneworkers, woodcarvers and brass- and iron-workers shared each other's zeal. When we think of the chancel screens or rood screens, the grilles, choir stalls, lecterns, bishops' "thrones," fonts, the most beautiful mellow glass that filled the richly traceried windows, the lovely illuminated psalters and missals that were used, we only think of details of that grandeur which the fourteenth century produced.

THE LOVELY LITTLE CHAPELS IN THE GREAT CATHEDRALS

During these generations most lovely tombs and monuments and shrines were set in the cathedrals. The story of these alone would make an entrancing book. Each in its way was as interesting as the Crusaders' monuments in the Temple Church; the mass of them show very great art. Lovely little chantry chapels were set, generally in the bay of a cathedral aisle, screened from public view by magnificent carving and ironwork. Here, in the days before the Reformation, masses were said for the souls of the dead.

Piety and a love of beauty lay in the founding of these chantries, built by people rich enough to maintain them. As we think of them we remember the night-watch of Henry V before Agincourt:

I Richard's body have interred anew,
And on it have bestowed more contrite tears
Than from it issued forcèd drops of blood . . .
                                        and I have built
Two chantries where the sad and solemn priests
Sing still for Richard's soul.

The Reformation and rebellion of the Puritans were the cause of the destruction of many of these fourteenth-century works of art. We can only be thankful that some are left, like that of Henry V himself in Westminster Abbey, Prince Arthur's Chantry in Worcester Cathedral, the Ramryge Chantry Chapel and St. Alban's shrine in the cathedral of St. Albans, the shrine of St. Thomas de Cantelupe in Hereford Cathedral, the tomb of Bishop Bridport in Salisbury Cathedral, the Percy Chapel in Beverley Minster.

THE CROSSES ON THE WAYSIDE FROM NOTTINGHAMSHIRE TO LONDON

A little of the romance of medieval England exists for us in the ruins of the Eleanor Crosses, set up at the order of Edward I in memory of his beloved queen, Eleanor of Castile, who died at Harby in Nottinghamshire in 1290. The body was conveyed for burial in solemn procession, by slow stages, from Nottinghamshire to Westminster Abbey. Afterward a cross was erected in each of the twelve places where the body reposed at the nightly halts.

The restoration of the cross at Waltham, near London, said to be finest of all, gives some idea of the richness of these memorials. One was erected at the village of Charing, the last halt before Westminster, hence the name, Charing Cross. It was taken down in the troubled seventeenth century, but a modern memorial in the station yard marks its site.

As the fourteenth century died away a slow change passed over architecture, and with the next hundred years came the end of Gothic in the Perpendicular style. This, as its name suggests, was a fashion of Gothic wherein the lines were drawn out long and pointed. It may be noted chiefly in the upright lines of the window, and the pointed panel shapes that decorated walls, outside and in, in every available space, even on the buttresses.

Buildings were thrown to a great height, windows became enormous. Fan vaulting was the chief characteristic in the very elaborate roof work of the period. Its finest example is in Henry VII's Chapel at Westminster, which is the best piece of architecture produced in fifteenth-century England.

The Church of St. Margaret, Westminster, was built in this style and also the Savoy Chapel, Westminster Hall, the porch of the Guildhall, St. Olave's Church, Hart Street, near the Tower, and St. George's Chapel, Windsor.

The Perpendicular period left its stamp on cathedrals like Winchester, Gloucester, Beverley and Sherborne minsters, Canterbury, Chester, the Beauchamp Chapel, Warwick. Manchester Cathedral was built during this time.

THE END OF THE GOTHIC SPIRIT IN ARCHITECTURE

No architecture to equal in importance that of the thirteenth or fourteenth century marked these generations. The Gothic spirit had spent itself. Constructionally, the work was becoming weaker, walls more and more like a patchwork of glass supported outwardly by enormous buttresses. Nothing more could be developed from the style. Early in the sixteenth century it died out.

In Westminster Abbey, more than any other cathedral, the various styles of Gothic met. This great building has an especial place in the hearts of English-speaking peoples, for its roots and its associations lie deep in their history. At the hands of the early kings, from the Confessor onward, it passed through many stages and received the impress of the various styles.

The church which is now called Westminster Abbey was originally part of a great group of buildings, monastery and royal palace, the palace making way for the Houses of Parliament. The monastery was one of the largest Benedictine institutions in Europe, and round it presently gathered ordinary dwelling-houses, like a village scattered about the monastery's feet. From this settlement grew the city of Westminster, an isolated town standing in the greenery and marshes of the Thames.

The monastery comprised the usual set of buildings—Abbey church, cloisters, refectory, dormitory, chapter house, mills, workshops, orchards. Its trout stream still flows, running under Great College Street to join the Thames. The monks' common court is now Dean's Yard. There was also an inner court which still exists as Little Dean's Yard. The abbot's house is now the Deanery, and this, with Jerusalem chamber and the dining-hall was rebuilt in the fourteenth century. Parts of the Confessor's Norman work still exist—the chapel of the Pyx, and the undercroft close by.

To Henry III belong the honors of rebuilding very nobly a good part of the Abbey church, which, in general plan, resembles the Cathedral of Rheims. It is 511 feet long, and the nave has the highest Gothic vault in England. Henry moved the famous shrine of the Abbey's founder, Edward the Confessor, to its place in the chapel immediately behind the high altar, where the Coronation chair also stands.

For some seven hundred years this has been the greatest, the most venerated tomb in England. Sick people were brought there to be cured, and places were arranged at the side of the shrine where they might be placed. The monument of Purbeck marble was defaced at the Reformation; its richly jeweled decorations destroyed. Later, in the reign of Mary Tudor, a fine canopy carved in wood was set over the tomb. During the World War this superstructure was removed for safety's sake, and afterward restored.

THE NOBLE BUILDING WHICH BREATHES THE HISTORY OF ENGLAND

In the Confessor's Chapel five kings and six queens are buried. And in the various chapels that group themselves about the apse, forming the chevet we have mentioned earlier, stand a great many very famous tombs and shrines, dedicated to the memory of royal persons. In Henry VII's Chapel are the arms of the Knights of the Bath, and several royal tombs. Apart from the memory of those immortalized, these tombs and monuments are examples of the art which was so rich in England during the Gothic period.

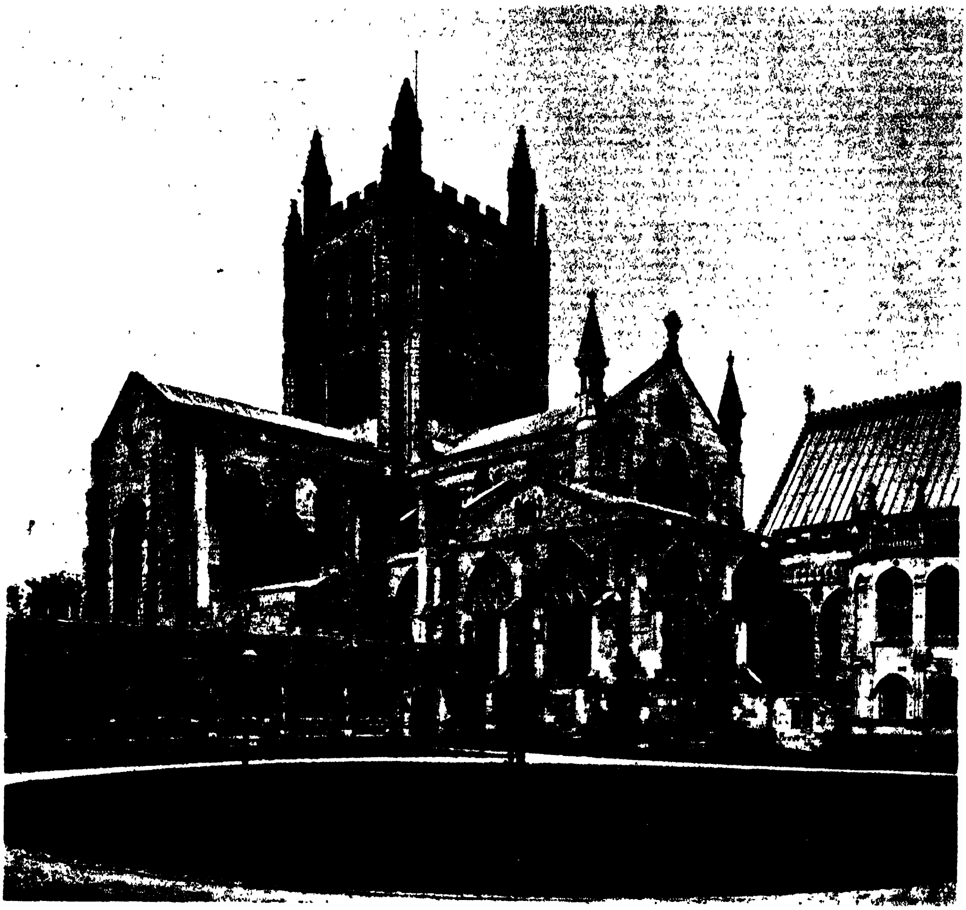
The Abbey has, unhappily, been seriously damaged by German bombs in World War II. In fact, a number of England's great and beautiful treasures of architecture have been damaged, some of them past hope of rebuilding. Our hearts are heavy when we realize that an air-raid in a single hour can wipe out beauty that had stood for centuries.

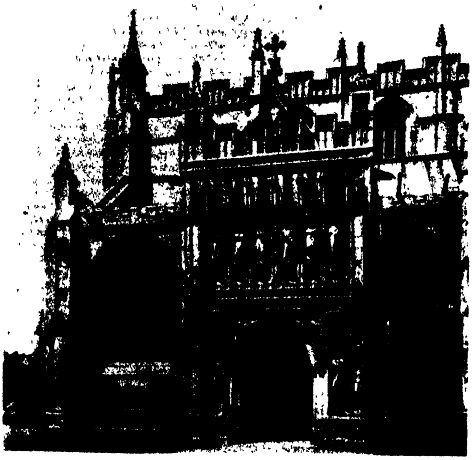
THE NEXT STORY OF THE FINE ARTS IS ON PAGE 6155.

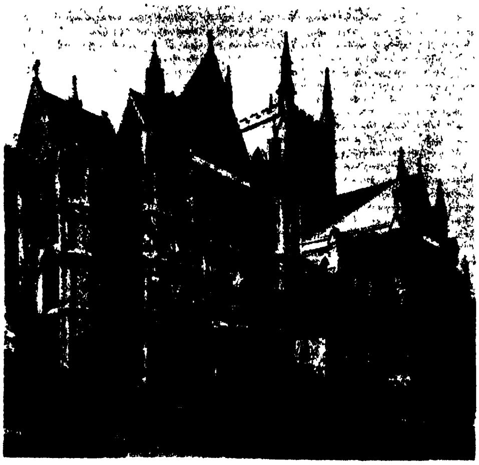
NORMAN AND GOTHIC BUILDINGS

CANTERBURY CATHEDRAL SEEN FROM THE SOUTHWEST

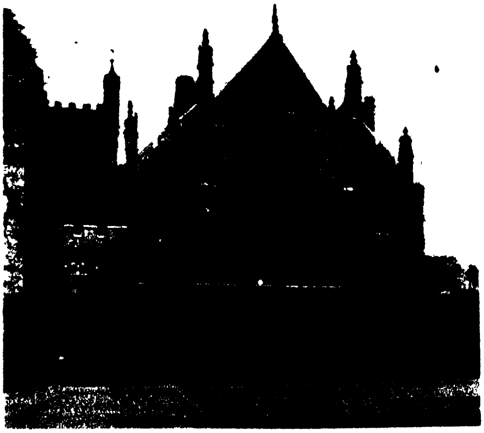
THE WEST FRONT OF YORK MINSTER, A BEAUTIFUL EXAMPLE OF THE PERPENDICULAR STYLE


HEREFORD CATHEDRAL AS SEEN FROM THE SOUTHEAST

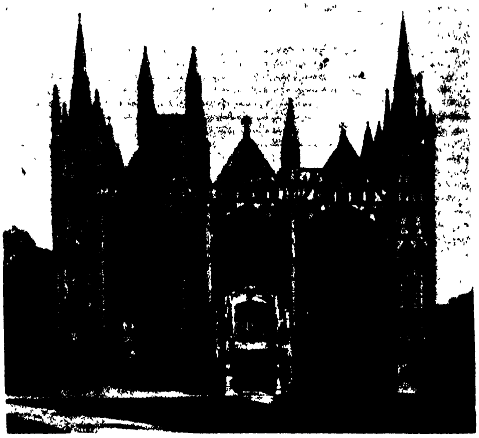

THE SOUTH PORCH OF GLOUCESTER CATHEDRAL


ROCHESTER CATHEDRAL BEFORE ITS RESTORATION

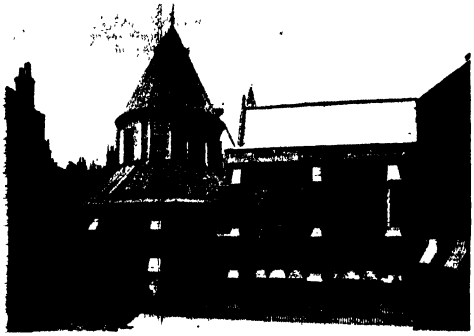
TEWKESBURY ABBEY AS SEEN FROM THE NORTHEAST



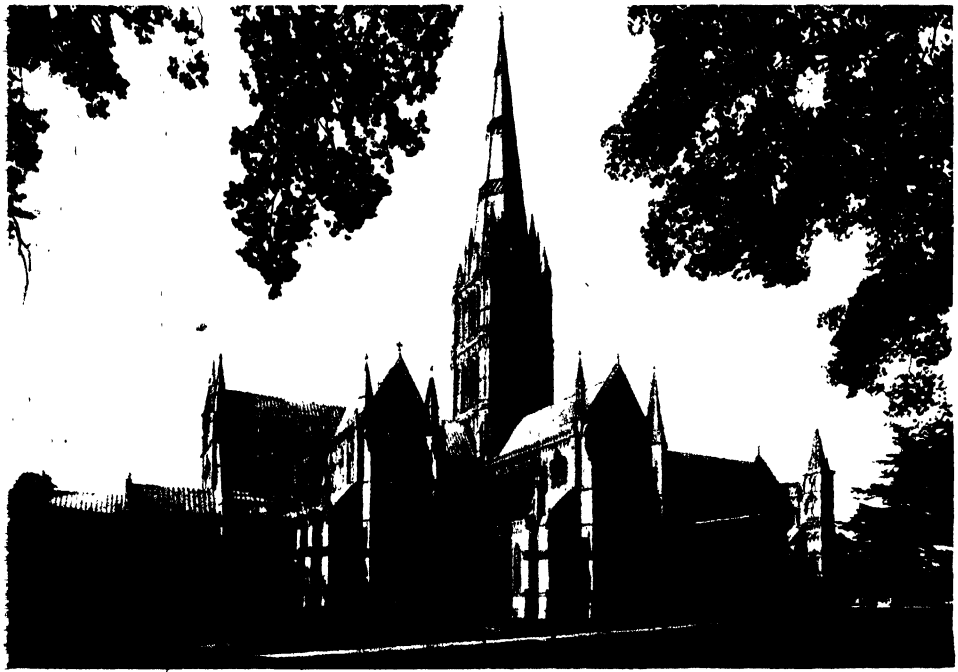
THE WEST FRONT OF EXETER CATHEDRAL

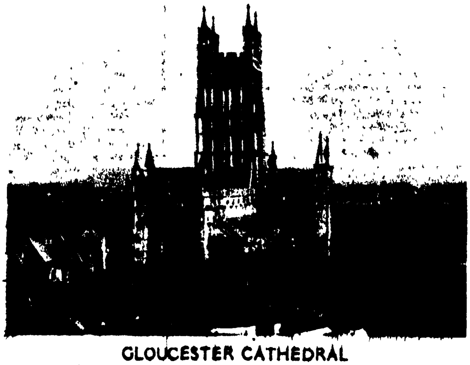


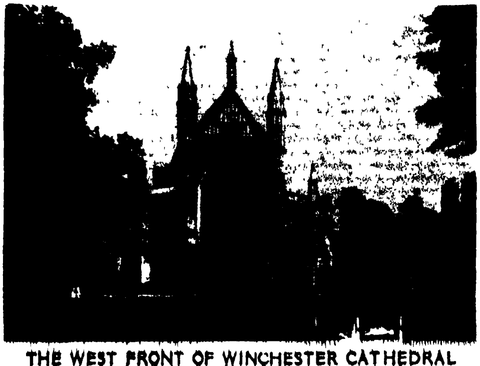
THE WEST FRONT OF PETERBOROUGH CATHEDRAL


THE TEMPLE CHURCH IN LONDON

THE WEST FRONT OF BRISTOL CATHEDRAL


SALISBURY CATHEDRAL, WITH ITS FAMOUS SPIRE


GLOUCESTER CATHEDRAL


THE WEST FRONT OF WINCHESTER CATHEDRAL

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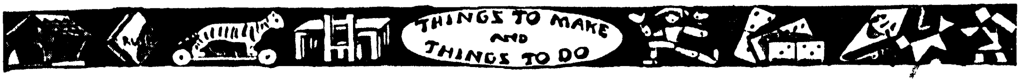
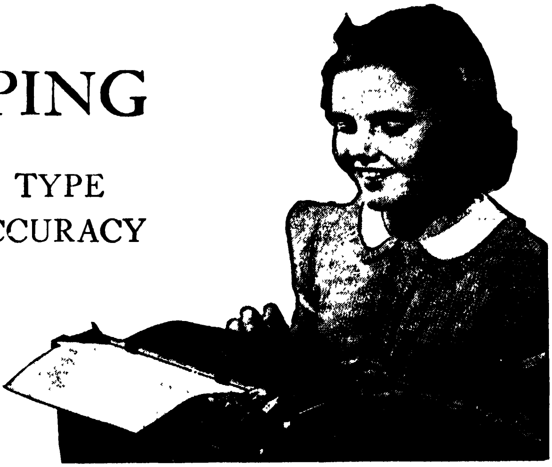

THINGS TO MAKE AND THINGS TO DO

TOUCH TYPING

HOW TO LEARN TO TYPE WITH SPEED AND ACCURACY



Illustrations, courtesy, Royal Typewriter Company, Inc.

THE typewriter is one of the most useful of all machines. If you can type well, you will be able to put your knowledge to use in a hundred different ways. Compositions, reports, articles for your school paper, personal letters to your friends—these are only a few possibilities. Besides, a person who knows how to type has a skill that will serve him well at all times. Authors, editors, newspaper men and women, advertising people, stenographers and others find the typewriter invaluable in their daily work.

There are various ways of typing. Some people use the rough-and-ready "hunt-and-peck" method. It consists of hunting all over the keyboard of the machine for each letter in turn, and then pecking away with one finger. Typing in this way is a slow and tedious business. It is also very hard on the eyes, since they must constantly wander from the copy (the material that is to be copied) to the typewriter keys and then back again.

To type really well, a person should use the touch method. In this system the typist memorizes the position of each key on the keyboard, so that he can strike any given key without having to look for (or at) it. Once you learn the touch method, you will be able to use all the fingers of both hands in typing, and you will be able to work with great ease, speed and accuracy. Then too, since you can keep your eyes fixed on the copy without ever having to look at the keyboard, your eyes will not be put under the strain of shifting back and forth.

In this article we are going to show you how to type by the touch method. If you follow carefully the instructions that we give you and if you practice faithfully, you will be able to type remarkably well in a comparatively short time.

The first thing to do in learning how to type is to become thoroughly familiar with your own typewriter. If you have the manufacturer's instruction book that comes with new typewriters, you should study it carefully. You should know the purpose of each of the devices on the machine and you should know how to operate these devices.

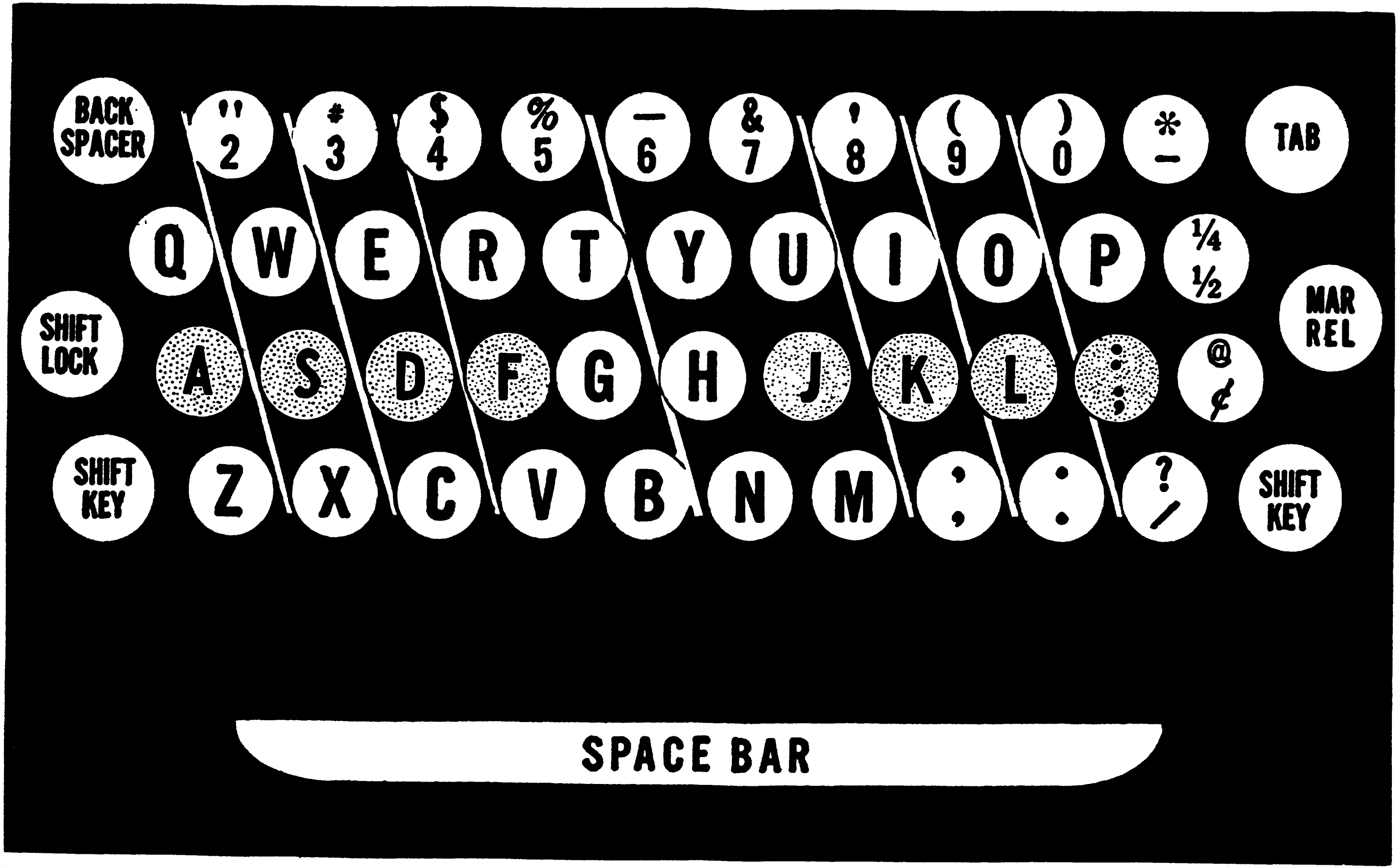
On another page of this article we show a standard typewriter, indicating by numbers the more important features. Following is a description of these features:

(1) *Keyboard.* All of the letters on the keyboard are called letter keys. If you look at Chart I in this article, you will see that some of the keys have only capital letters. Other keys have numerals, punctuation marks and various other characters. For example, the first key on the left in the top row has " and 2; the second key, # and 3; the third key, $ and 4 and so on. When you press down a key with a capital letter on it, a small letter will appear on the paper inserted in the typewriter. Thus, if you press down Y, you get y. When you press a key that has two things on it, only the lower one will appear on the paper. If you press down the key that has " and 2, 2 will appear.

(2) *Shift Keys.* When you want to make a capital letter, you press down the shift key and then strike the letter key. When there are two things on a letter key (like " and 2), the upper one will appear on the paper when the shift key is held down and the letter key is struck.

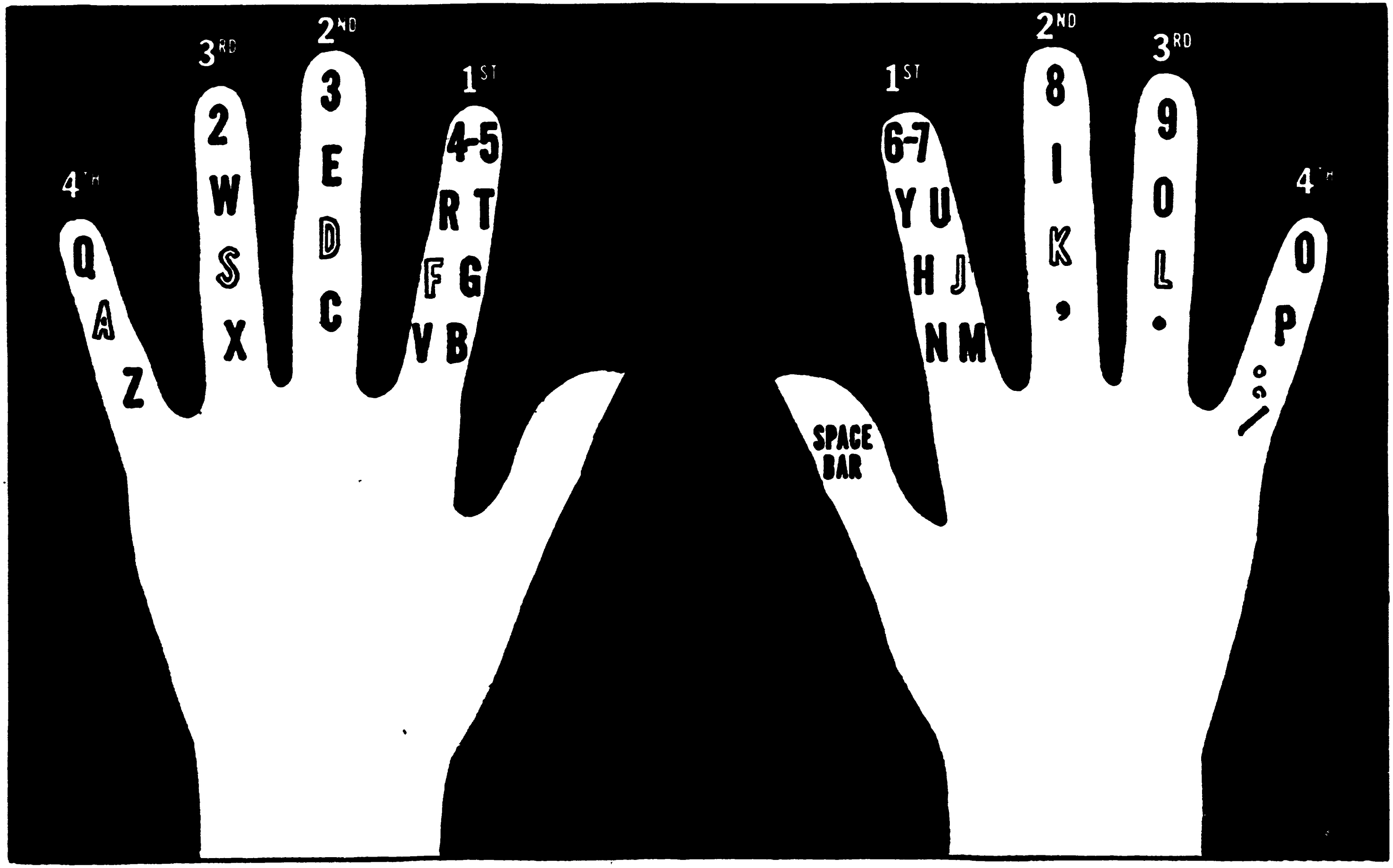
(3) *Space Bar.* When you want to leave a space between words, you press the space

SPEED TYPING CHART NUMBER I

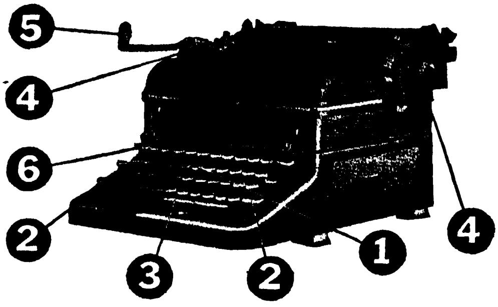


We show here a standard keyboard. The fingers rest on the home keys, which are stippled (that is, dotted) in the chart. The first finger of the left hand rests on f; the first finger of the right hand rests on j. The white lines running from top to bottom separate the keys into the groups which each finger strikes.

SPEED TYPING CHART NUMBER II



The letters that each finger strikes are shown above. The left thumb is not used in typing; the right thumb operates the space bar. If the shift key is not held down when a letter is struck, a small letter will be printed; otherwise a capital will appear. The numerals are printed when the shift key is not held down.



This picture shows some of the important parts of a typewriter: (1) the keyboard; (2) the shift keys; (3) the space bar; (4) the cylinder knob; (5) the carriage return lever; (6) the back spacer key.

bar. The typewriter carriage (the movable part on the top of the typewriter) will move the paper one space for the next letter.

(4) *Cylinder Knobs.* You put the paper in the typewriter by inserting it behind the cylinder; then you turn the cylinder knobs until the paper comes up to the point where you want to write.

(5) *Carriage Return Lever.* When you have come to the end of a line and want to move the paper to the start of the next line, you move the carriage across by pressing this lever. At the same time the paper is rolled up to the start of the next line.

(6) *Back Spacer Key.* When you want to go back a space, you press this key.

These are the chief controls of every typewriter. There are other controls with which you should be familiar. *Margin stops* are set to mark out the left-hand and right-hand margins of the paper. The *margin release* permits you to pass over the margin stop and to write in the margin. You use the *paper bail* or *paper fingers* to hold the paper firmly in place against the cylinder. The *ratchet release* and the *variable spacer* are used to write between the lines. You use the *ribbon color change lever* with a two-color ribbon so that you can write on either the black or red part of the ribbon. With the *space adjuster* you can provide single-spacing or double-spacing between lines.

These controls are set in different places in various kinds of typewriters; they are also operated differently. It will be well for you to find out how each operates by studying the instruction book that comes with the typewriter. If you have none, ask somebody who knows how to type to show you where the controls are and how they work.

In learning to type, it is very important to sit properly at the machine and to hold one's hands correctly over the keys. (1) The head is held erect; it is turned slightly to the right with the eyes on the copy. (2) The forearm, from elbow to fingers, is held so as to form a single straight line. (3) The hands are held close to the frame of the typewriter; they should be parallel to the keyboard. (4) The copy is on the right side of the typewriter. (5) The feet are flat on the floor. They may be slightly apart and one may be an inch of two ahead of the other.

You are now ready to learn to type by touch. The Speed Typing Charts shown on the two preceding pages of this article will be your guide. First, open your book to these pages and put it in position on your right as you sit at the typewriter. Place the first finger of the left hand on f, the second finger on d, the third finger on s and the fourth or little finger on a. These are the *home keys* for the left hand. Place the first finger of the right hand on j, the second finger on k, the third finger on l and the fourth finger on the semicolon. These are the home keys for the right hand.

Next, look at Chart I. The home keys are stippled (that is, dotted) on the chart. Each finger rests on the home key when it is not in use. It leaves its home key to go up or down to other keys; then it returns to the home key. The thin white lines running from the top to the bottom of the chart separate the keys into the groups each finger strikes. The letters each finger strikes as shown on the picture of the fingers in Chart II. By looking at the two charts you will be able to tell instantly which fingers strike which keys. Do not try to memorize all this now. You will learn by practice.

The exercises that follow contain material for practice. Do not type any of these exercises until you have read carefully the explanations that accompany them.

(1) *First Finger Words:* jug, fur, hug, rut, fun, mug, bug, thy, nut, fry, rub, buy, try, tub, gum, gun, buff, burn, hung, fury, hurry, funny.

These words require only the use of the first fingers. Hold the fourth fingers lightly on their home keys (a and ;) while typing with the first fingers. Keep your eyes on the copy, *not* on the keys. Strike the keys with a quick hammer-like action; release quickly. To provide space between words, strike the space bar with your right thumb. When the bell strikes, meaning that you are near the end of the line, finish the word you are writing; then return the carriage with the left hand without raising your eyes from the copy. Devote a whole line to each word in turn; use no commas between words. Your typed page will look like this:

jug jug jug jug jug jug jug jug jug jug
fur fur fur fur fur fur fur fur fur fur
hug hug hug hug hug hug hug hug hug hug

(2) *First and Second Finger Words:* jig, her, den, kit, kid, the, ice, get, ivy, due, tin, red, bin, tie, cur, die, rid, gem, key, men, eve, big, jet, ten, beg, fir, gin, fib, icy, him, rue, net, cut.

These words require the use of the first and second fingers. They are to be practiced in exactly the same way as the first finger words above.

(3) *First, Second and Third Finger Words:* jog, who, sob, won, cod, low, fox, you, now, lie, jot, tow, rob, two, sew, mow, got, why, few, let, cot, led, tree, fuss, dust, fort, stir, lyre, shut, lick, trod.

(4) *Words Typed by All Fingers:* far, pay, bay, nap, pin, cat, air, lad, pad, tap, was, eat, hem, gap, man, yap, nag, law, day, are, sop, has, age, lax, wag, yak, ear.

(5) *Complete Sentences:* Think before you write. In the best books great men talk to us; they tell us their most precious thoughts. It is in time of need that we go to a friend for help and sympathy. FRENCH IS SPOKEN HERE (use capital letters only). Mr. Jones lives in Boston; Mrs. Smith in Akron. Send for Dr. Stone.

Note that to make a capital letter with any finger of the right hand, you must hold the opposite shift key down securely with the left fourth finger, keeping the first left finger on its home key (f). To make a capital letter with any finger of the left hand, hold the opposite shift key down with the right fourth finger, keeping the right first finger on its home key (j). If you wish to write a word or a whole series of words all in capitals, press the shift lock; it will remain in position after you have lifted your finger. To release the shift lock, press the shift key. Leave one space after an abbreviation; two spaces after the end of a sentence. Write each sentence above at least ten times.

(6) *Numerals and Other Characters:* 324; 1,493; 25,324; 6⅚; 8⅞; $7,421.48; 64%; June 30, 1940; 15 — 3 = 5; 77 — 43 = 4. Dobbs & Crosby. Do it now. Please send me 100 bolts of the #7 sheeting. Paul's car is new. "Come here," he said.

The first finger of the left hand types 4 and 5, the second finger 3 and the third finger 2. On the right hand the first finger types 6 and 7, the second finger 8, the third finger 9 and the fourth finger 0. The number 1 is obtained by striking the letter **l**. Certain fractions (such as ½ and ¼) are found on the outer right-hand keys of most typewriters. To make other fractions use the character /. For example, one-thirtieth would be 1/30. Space once between a whole number and a fraction, thus: 3 1/3.

To type any upper case character (that is, a character printed at the top of a key), use the shift key. To underscore a word, first write the word. Then backspace until you come back to the first letter of the word. Strike the underscore key (___) as many times as there are letters in the word to be underscored, thus: again. If there is a good deal of material to be underscored, push the carriage back by hand.

To make a multiplication sign, type small x. To make a minus sign, type a hyphen (-). To make a division sign, type a colon on top of the hyphen (use back space key and then shift key), thus: ÷. To make an equal sign, type a hyphen beneath a hyphen (use back space key and then turn cylinder), thus: =. Leave one space before and after an arithmetical sign. To make an exclamation mark, type the apostrophe over a period (use back space key and then shift key), thus: !

(7) *Special Exercises.* A quick brown fox jumps over the lazy dog. The bank recognizes the claim as valid and quite just, and we expect a full payment. A large number of our citizens have signed a petition which makes request for a more just system of taxation.

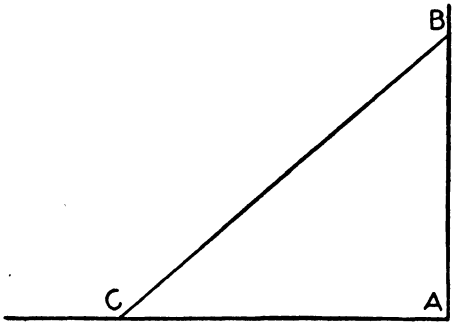
Each of the above sentences contains all the letters of the alphabet.

Above you have in a nutshell all that you need know in order to learn to type speedily and accurately. The progress you make will depend entirely on yourself. Here are some useful hints for you: Learn only one thing at a time. Do not begin work on a new set of exercises until you have mastered all that goes before. The important thing at first is accuracy, not speed. Speed will come later; you may be sure of that. Above all, practice, practice, PRACTICE!

Article, courtesy of the Royal Typewriter Company, Inc.

HOW TO MAKE AN ELLIPSE

BOYS and girls sometimes have occasion to draw ellipses for various projects. (An ellipse is a kind of flattened circle; see Figure 4.) For example, a title set in an ellipse on the cover of a notebook is very effective. Or perhaps you may wish to use a series of ellipses in a design. "How unfortunate it is," you may say, "that I can't make a perfect ellipse—one that will be as perfect as a circle that I draw with a compass!" As a matter of fact, it is quite easy to make a perfect ellipse of any desired dimension, as you will see.



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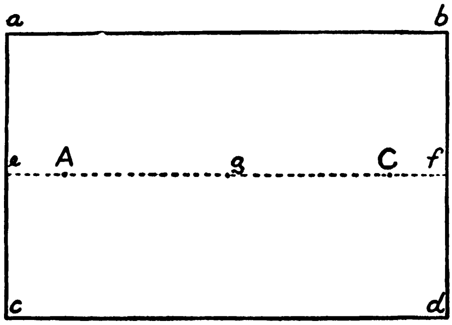

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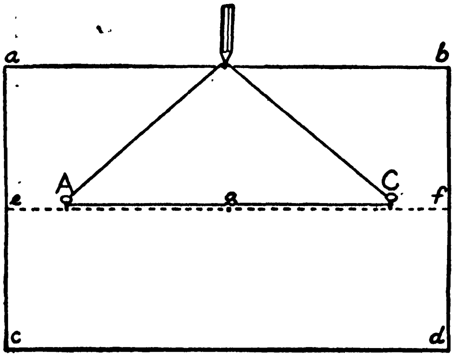

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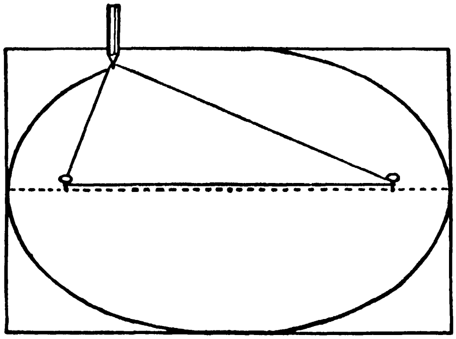


4.

The first thing to do is to lay out a right angle on a piece of paper—any piece of paper—by means of a steel square or any similar instrument. Suppose, now, that you want to construct an ellipse that will be 3 inches long by 2 inches wide. Measure the width of the ellipse—2 inches, in this case—on one leg of the square. This distance will be AB in Figure 1. Next, take a piece of string exactly as long as your proposed ellipse—3 inches. Hold down one end of the string at B and, keeping the string taut, find the spot where it hits the other leg of the right angle—C.

You are now ready to make your ellipse. First draw a rectangle (*abcd* in Figure 2) with the proposed dimensions of your ellipse—3 inches by 2 inches—in the place where you wish to use it, say on the cover of a book. Draw the line *ef* midway between *ab* and *cd*. Find the center of this line—*g*. Then measure off the distance AC, in Figure 1, on the line *ef* in such a way that *g* will be in the center. Next, set two thumbtacks in place at A and C, as in Figure 3. Provide yourself with a loop of string or strong thread which will be equal in length to AC plus BC.

Place the loop of string around the two thumbtacks and also around a pencil, pushing the pencil away from the thumbtacks until the string is perfectly taut, as shown in Figure 4. Then draw the ellipse with the pencil, keeping the string taut. Finally go over the figure with pen or brush, first erasing all the other lines. And there you have your perfect ellipse!

THE GAME OF TENNIS

TENNIS is one of the most popular of all sports and it does not require a great outlay for equipment. A tennis racket, half a dozen balls and a pair of sneakers—with this outfit you are ready to take part in this sport. To the items we have named you may have to add a tennis net, if one is not provided at the court where your friends play.

Some players are fortunate enough to have a private tennis court to play on. There are also suitable courts in many public parks and playgrounds. The diagram on this page shows how a court is laid out.

Be sure to provide yourself with as good a racket as you can afford. You should see to it that the strings of the racket are as taut as possible and that you can grip the handle comfortably. The weight of the racket should be about 12 ounces for a boy or girl of twelve.

Tennis may be played by either two or four players. A game that is played between two players is called *singles*; a game between four players is called *doubles*.

THE SINGLES SIDE LINE SERVES AS THE SIDE BOUNDARY IN SINGLES

We will start with the singles game; for this the singles side line (see the diagram) serves as the side boundary. Before we start playing, the net must be raised to a height of three feet in the center of the court, and the players should toss for the choice of service or of court. If the player who wins the toss chooses the court, the loser serves; if the winner chooses to serve the loser chooses the court.

The object of the game is to hit the ball into our opponent's court in such a way as to make it impossible for him to return it into our own court. Every time our opponent fails to get the ball in our court, it adds to our score; every time we fail to put the ball in his court, it adds to his score.

THE SERVICE STROKE IS ONE OF THE MOST IMPORTANT IN THE GAME OF TENNIS

The server must stand behind the base line to the right of the center, and tossing up the ball with his left hand, he must strike it with the racket before it reaches the ground, so that it will fall in the right-hand service court on the other side of the net. If, on his first try, a server hits the net and the ball falls into his opponent's court, a *let* is called and the server is entitled to two more tries. If a let is called on the second of two serves, the server has one more try. If the server fails to get the ball into his opponent's service court on the first try, the service is called a fault and he tries again. If the second service also does not fall into the opponent's service court, a double fault is called, and the opponent scores a point. The ball must be hit before the server puts his foot over the service line or else a fault is called. It is also a fault if one foot at least does not touch the ground at all times during service. If the server hits the ball into his opponent's court in such a way that this opponent can not return it successfully, the server scores what is known as a *service ace* and a point is added to his score.

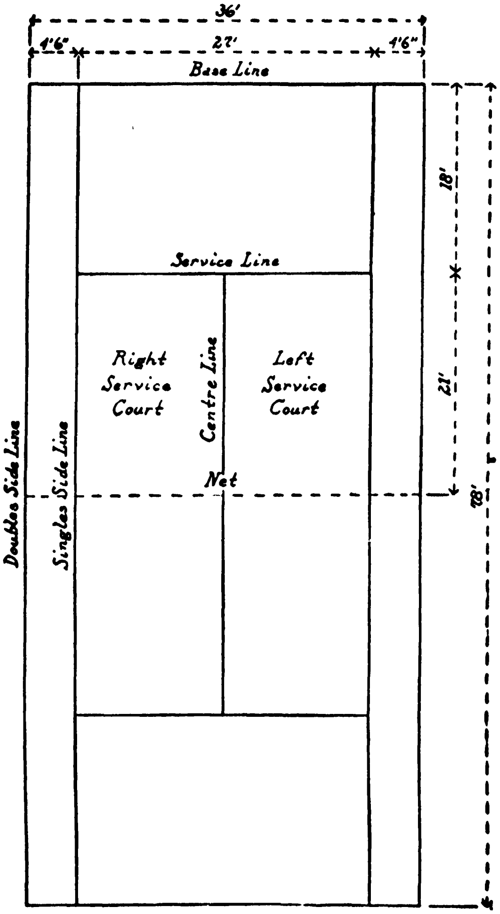


Diagram of Tennis Court.

The receiver should stand back of his right service court (generally near the base line), ready to hit the ball on the first bounce. He is allowed to hit the service stroke only in this way. After this first stroke, both players may either hit the ball on the first bounce, or else they may hit the ball before it touches the ground. This latter stroke is called a *volley*. If a player lets the ball bounce a second time, his opponent wins the point. In a singles game (just two people playing), the receiver must return the ball to land inside the base line and between the singles court sidelines. The two players hit the ball to and fro over the net to each other until one fails to return the ball within his opponent's court.

A DESCRIPTION OF THE SCORING SYSTEM IN THE GAME OF TENNIS

When a player wins his first point, his score becomes 15; when he wins the second, 15 more is added to his score, which becomes 30; when he wins the third, 10 is added and his score becomes 40. To indicate a tie score, *all* is used in the sense of *each*—for example, *30 all* means *30 each. Love* is used to indicate zero; thus, if we say that the score is *15 love,* we mean that it is *15 to nothing*. The server's score is always given first. If one player reaches 40 before his opponent and then wins the next point, he wins the game. If both players reach 40, it is called *deuce* and a player must win two points in succession before he wins the game. When he wins the first point, it is called his *advantage* or *ad;* if he loses the second point, deuce is called again.

When the first 15 points have been won by either the server or receiver, the server delivers his second service from the left-hand side into the service court diagonally opposite him, and the receiver also moves to his left-hand side. This alternation of courts is continued until the first game has been won.

When the first game has been completed, the receiver becomes the server; he continues to serve until the second game has been completed. The players serve in turn in this manner until one of them wins the set. A player wins a set if he wins six games while his opponent has been able to win only four or less. If both players have won five games, they continue to play until one of them is two games ahead of the other.

The players change sides of the net at the end of the first game, at the end of the third and so on (that is, at the end of every alternate game). If an even number of games has been played in a set, the players do not change courts to begin the next set. If an odd number of games has been played, the players change courts to begin the next set.

The player who first wins two sets is generally declared the winner in informal play. In tournaments and in formal competition generally, men's singles are decided by three sets out of five and women's singles by two sets out of three.

There is no difference in the scoring in doubles, but a larger-sized court is used. The doubles side lines (see the diagram) are used as the side boundaries and the side lines of the singles court are used only as boundary lines for the service strokes. The two sets of partners serve as follows. Let us suppose that W and X are playing against Y and Z. W serves first and continues to serve until the first game has been won. Y serves throughout the second game. X takes over service for the third game, and then Z for the fourth. W serves first from the right-hand side of the court to Z. When the first 15 points have been won by one side or the other, W changes sides in his court with his partner X and he serves from the left-hand court to Y. When the first game has been won, Y serves from the right-hand side of the court to W. Only the server and his partner change positions during the playing of a single game. After the serve, the partners try to avoid getting into each other's way. Sometimes one partner gets the balls that fall near the net while his partner gets those nearer the base line; or else it is decided that each is to get the balls that come on his side of the center line.

A FEW SUGGESTIONS FOR PRODUCING THE VARIOUS TENNIS STROKES

There are many different methods of producing the various tennis strokes. Following are a few useful suggestions. The racket should be held firmly at the end with the thumb pointing toward the tip of the index finger for serving and for hitting the ball when on our right hand—the forehand stroke. For hitting a ball coming to our left—the backhand stroke—it is best to move the thumb so that it points along the length of the racket, which must be turned so that it will strike the ball with the face opposite to that used for the forehand stroke. For the overhead serve, the racket should be swung so that the center of the racket hits the ball as high as possible; then we should follow through toward the left.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 6024.

Courtesy, Chicago, Burlington and Quincy Railroad

This spirited painting by Hoffman shows lumber jacks with cant-hooks, canting logs into a river.

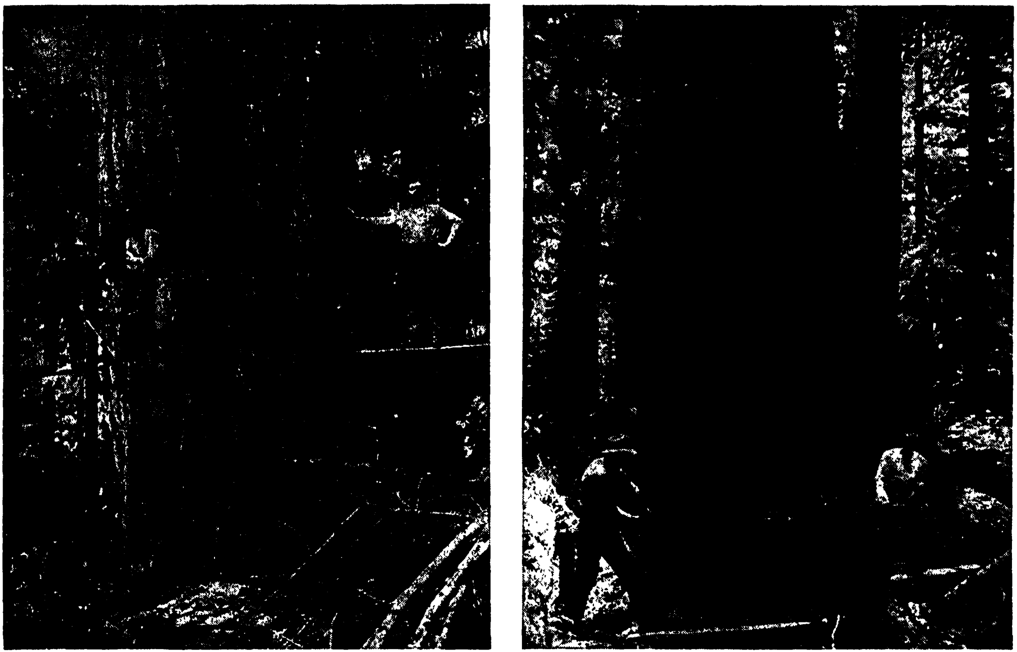
THE WEALTH OF THE FOREST

WE have read, on page 2803, about the forests of the United States and their guardians. Now we shall read of the way in which men take from the forests lumber for building and other purposes. The chief regions where timber was cut before 1870 were the New England and Middle Atlantic states. Ten years later the Lake states were leading in lumber production, to give place later to the southern states and finally to the Pacific coast states. Nowadays much more than half of the softwood saw timber is found in the Pacific coast forests, especially in the states of Washington, Oregon, Idaho and Montana. The best softwood trees are the Douglas fir, southern pine, western yellow pine, western hemlock, true fir and redwood. The best hardwoods are found in the eastern forests, and they are oak, birch, beech, maple, walnut and red gum. There are many other trees of both kinds which are useful as lumber, and of these you may read on pages 4507 and 4635.

We are interested now in the method of getting the trees out of the forest and to the mill where they are cut into planks. Early logging was carried on near settlements where the surface of the country was favorable. The work was done largely by settlers who cut the logs during the fall and winter and hauled them over the snow to the mill or to a river which ran to a mill.

The first lumbermen in the United States used to fell all their trees with axes, but now a logger uses an ax for small trees only. By this method a wedge-shaped notch, or undercut, is made on the side of the tree-trunk in the direction in which the tree is to fall. On the opposite side to the undercut, and slightly higher, the woodman cuts another wedge-shaped notch deep into the heart of the tree until the tree falls. That is a wasteful method, so now a crosscut saw is used to aid the ax. The undercut is made as usual, but the saw is used to cut through the trunk. As the saw eats into the tree, wooden or iron wedges are driven into the cut behind it. A crosscut saw needs two men or a gasoline engine to operate it, and the mechanical saw is being used to some extent.

When the tree is lying on the ground an ax is used to lop off the limbs. Sometimes the trunks are cut by crosscut saws into logs varying in length from ten feet to sixty feet, according to the kind of tree and the



Courtesy, U. S. Forest Service   Courtesy, Portland Chamber of Commerce

Douglas firs being felled. First, a great notch is cut on the side of the tree towards which it is proposed to have it fall. (This is called undercutting.) Then the trunk is sawed through to the notch, from the other side.

method of getting the logs to the mill, and other conditions.

There are many ways of transporting the logs from the forest. The logging engineer uses sleds, wagons, railroads, aerial trams, slides, flumes, steam and electric skidders, tractors, tugs and barges.

When the land surface is rough, flumes and slides may be used. A flume is a wooden trough, sometimes miles in length and wide enough to take a large log. This trough is filled with water on which the logs are floated to their destination. Slides are chutes running down hillsides, and they may be just grooves in the earth or they may be made of timber. When a log is placed on the top of the slide, or chute, gravity keeps it sliding until it reaches the bottom. Often the chute ends in a stream.

When the land surface is comparatively flat, wagons drawn by horses or tractors may be used to haul out the timber. Often a railway line is run into a thickly wooded country and the logs are loaded on to flat cars. Those who have seen railway engines hauling cars of logs may have wondered at the strange-shaped box on the smoke funnel. This is a spark-arrester with a screen which lets steam, smoke and gas pass through, but catches the dangerous bits of fiery material that might set a whole forest on fire. The laws of most states require the use of a spark-arrester on wood-burning and coal-burning machinery used in the woods.

Sometimes the logs are dragged, or "skidded," along the ground. This method is used for short-distance hauls and with shorter logs. Transporting long logs in this way bruises or breaks a large amount of young growth. In the eastern part of the United States a sled called a go-devil is used in the summer and fall for hauling. This rough sled has two unshod hardwood runners curved up at the front, and is pulled by chains. In sections of the country where there is a heavy snowfall, during the winter real snow-sleds are used to transport the logs to the nearest icebound stream of adequate depth. The logs are unloaded on the ice, and when in the spring the ice "goes out," the logs float downstream with the current. The sight of a river full of logs is not soon forgotten.

Water transportation has always been a great factor in lumbering in this country. Nearly every large stream in the forest regions has, at one time or another, floated logs to mill. The use of rivers as lumber highways is still a common method of lumbering in the eastern states. On the Pacific coast water transport, except on the Columbia River, Puget Sound and the Pacific Ocean, is of secondary importance because of the great diameter and length of the logs.

Where water is used logs may be floated singly or in rafts. On rough water and small streams rafts are rarely used. On navigable rivers rafting is compulsory. Water transport is the cheapest method of moving logs for long distances, but it has disadvantages. It is limited chiefly to logs which will float, so many hardwoods cannot be carried. There is always a loss through sunken and stranded logs, and also logs are often badly battered by passing over rocks, rapids or falls. Floods and storms are sources of loss to lumbermen who work on large streams, for the booms confining the logs break, and loose logs are carried downstream past their destination. As each log is branded or painted with the owner's sign, some of the lost property may be recovered, but a lot is lost.

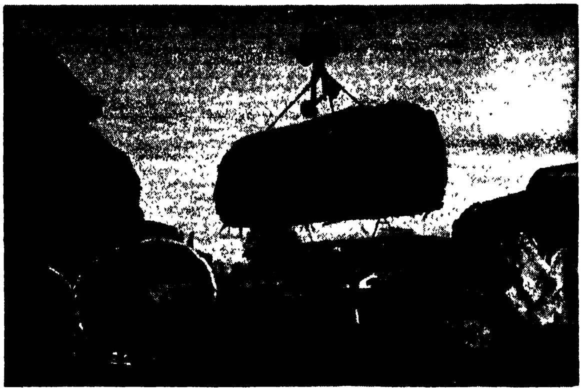
In the Pacific coast regions logs are often rafted down the larger streams and towed along Puget Sound to the mills. But the log rafts of greatest interest are the huge cigar-shaped ones which are towed from the mouth of the Columbia River to San Diego, California. These rafts are known as the Benson type, and are from 700 to 1,000 feet long, from 50 to 60 feet wide and from 30 to 35 feet deep at the centre. These ocean-going rafts are bound together by strong chains. A 700-foot raft containing from 4,000,000 to 5,000,000 board feet is bound with about 115 tons of chain. An ocean tug tows it across 1,500 miles of ocean.

When the logs finally arrive at the sawmill they are subjected to many kinds of saws before the finished planks are carried out into the lumber yard to be seasoned, and before being sold for building purposes. Seasoning, that is, removing the moisture from the lumber, is done in two ways. In small mills the lumber is seasoned by piling it out of doors to dry in the open air. In large mills there are dry kilns, or heated rooms in which the lumber is dried. The outdoor method is better, but it takes a longer time than the other. The pictures which form part of this article give a very good idea of different stages in lumbering.

Courtesy, Champion Paper and Fibre Co.

Measuring a felled tree. Two chief uses of lumber are for building purposes and for furniture. For building, softwoods, such as various pines, cedars, Douglas fir, hemlock, spruce and others, are used. Hardwoods, including oak, maple, walnut, birch, elm, basswood, hickory and gum, go to make furniture. Great quantities of felled trees each year also go to make paper, and to the mills which convert cellulose into many products. See page 2747.

LOGS FOR VARIOUS USES



Redwood Empire Association

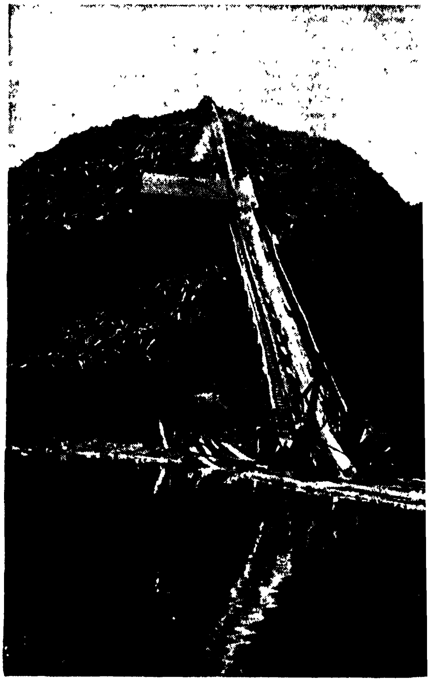
A log of a giant California redwood is hoisted to a heavy, double-tired truck body for transportation to the mills. The wood from these trees is a handsome brownish red.

National Film Board

Running logs through sorting gaps at the end of a drive. Standing on rafts strung out into the river, the men sort and then mark the logs according to the kind of wood.

Photo by U. S. Forest Service

Since logs take up so much space, most saw- have a pond near by where the logs may be fore the logs are run through the saws, they

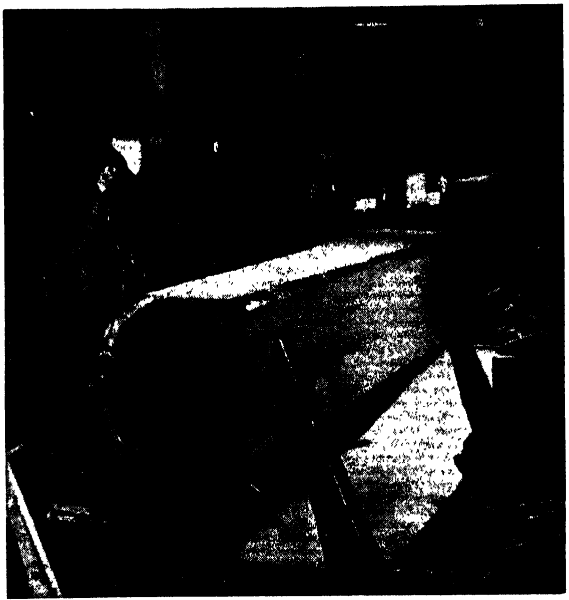


Maine Development Commission

A pile of pulp wood grows as a long conveyor carries the short pieces of wood to the top. Several thousand cords are in the pile.

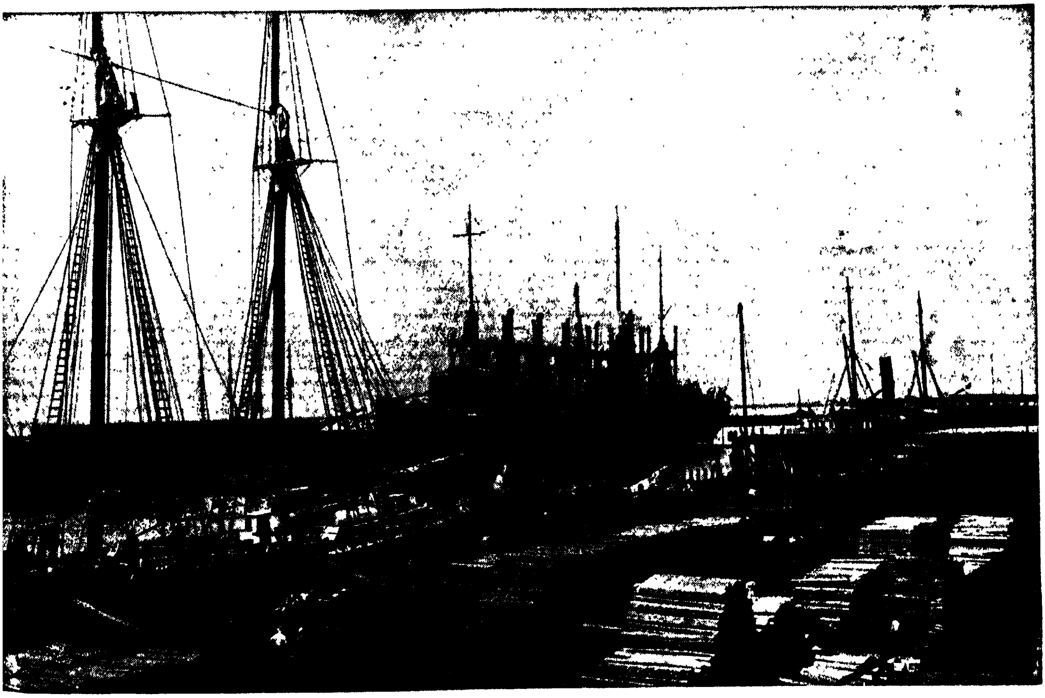
FROM LOGS TO RAILROAD TIES

mills and shingle mills, like those above, kept in floating "storage" until needed. Be-
must be stripped of bark and branches.



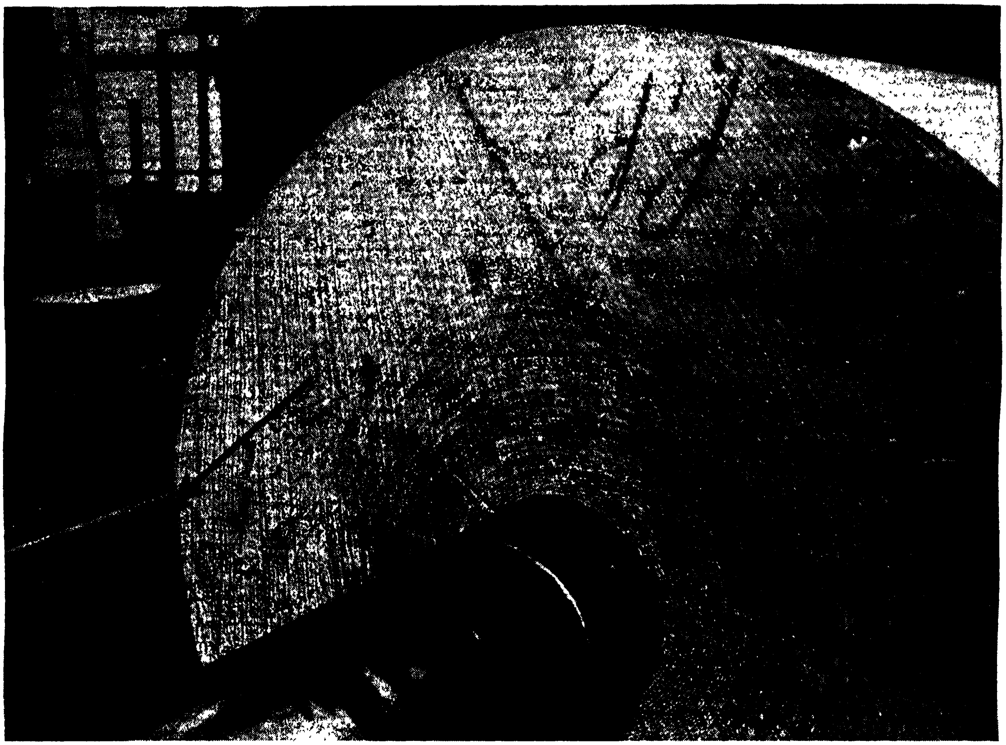
Courtesy, Weyerhauser Sales Co.

Each log is partly squared, or canted. Then it is placed on a carriage truck; and the saw is set to cut slices of the desired thickness. As the boards drop off, the log is moved forward.

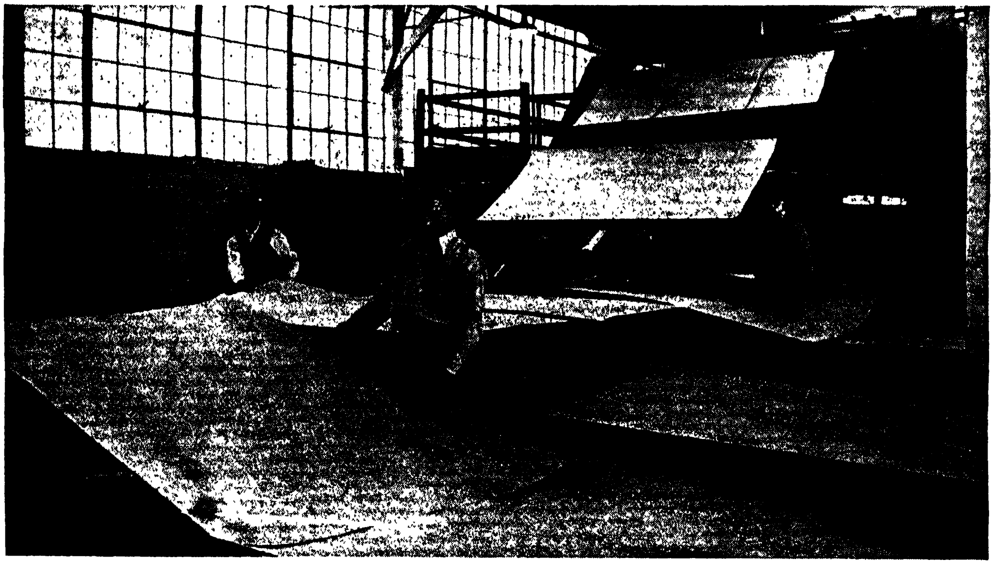


Piles of lumber awaiting shipment by boat. Each pile contains boards of the same kind of wood, cut in uniform sizes. Lumber is usually ordered in certain standard sizes, which saves time where wood is being used in construction. The lumber in some of the piles in this picture is cut in the proper shape and size for railroad ties.

HOW PLYWOOD IS MADE



Very thin sheets of wood are cut from logs by this ingenious machine. The arrow points to a knife-edge. The log is whirled upon a lathe so that the outer edge meets the knife, and a continuous thin sheet is cut.



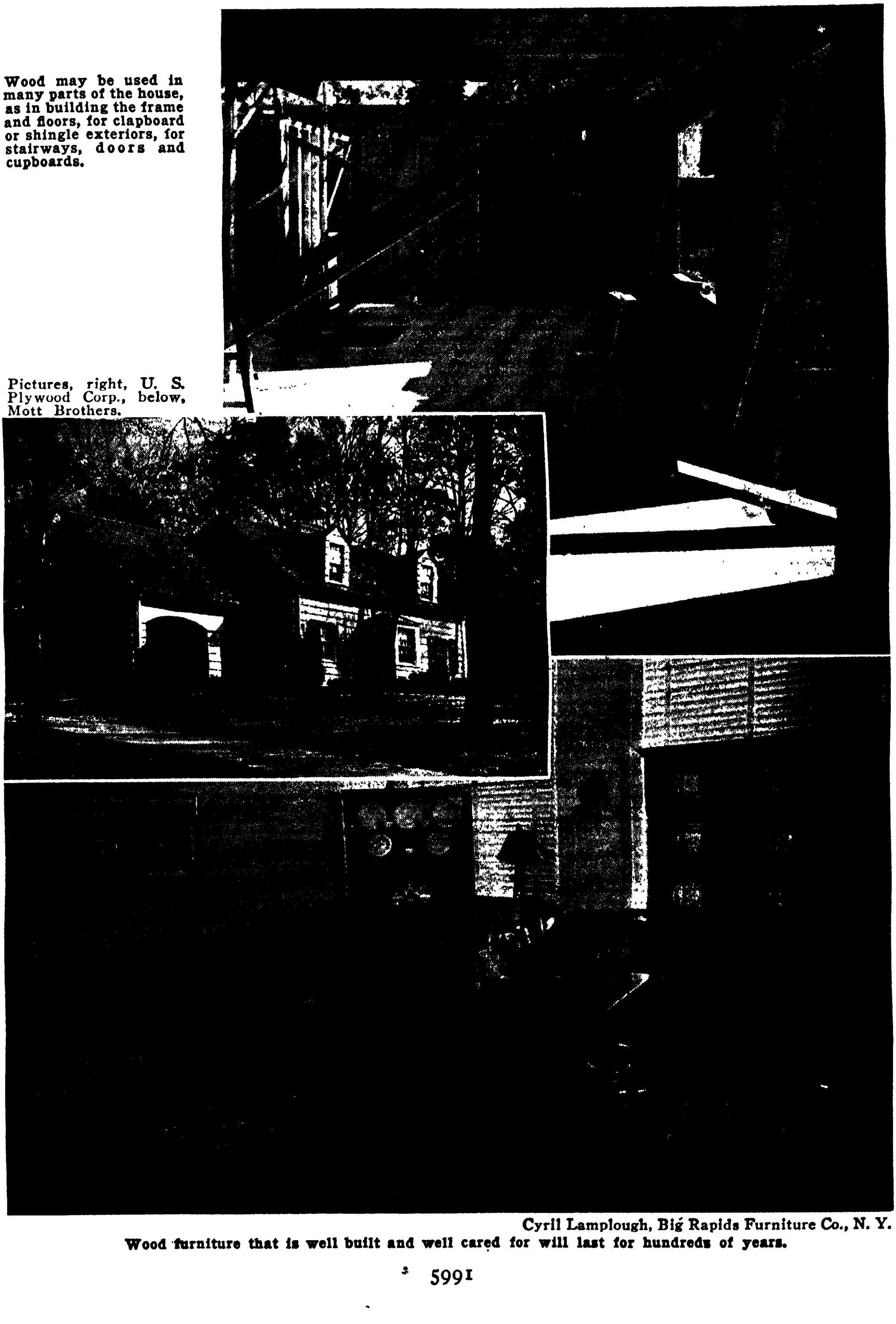
Pictures, U. S. Plywood Corp.

The thin wood is then cut into large pieces, as here. A number of pieces in layers, bound together by an adhesive, with their grain at right angles to each other, make plywood. This is a strong material with many uses.

WOOD FOR BUILDING AND FOR FURNITURE

Wood may be used in many parts of the house, as in building the frame and floors, for clapboard or shingle exteriors, for stairways, doors and cupboards.

Pictures, right, U. S. Plywood Corp., below, Mott Brothers.



Cyril Lamplough, Big Rapids Furniture Co., N. Y.

Wood furniture that is well built and well cared for will last for hundreds of years.

From All the Children

Does handling tools appeal to you? A mechanical aptitude test will reveal how much ability you have.

CHOOSING A VOCATION

WHAT am I going to do in life? That is a question that comes to every teen-age boy or girl. Not that it has to be decided then; but it does have to be decided presently, for he who eats (and raises a family, and lives happily) must work.

In earlier times, the choice was much easier to make. Most boys learned how to farm, or make furniture, or do other things by helping their fathers. Or they became apprentices to some skilled workman in the neighborhood. Only a few went to college to become ministers, teachers, lawyers or doctors. Girls looked forward to a career as homemaker, and learned the work in their mother's home.

Today the question is not so easy, because conditions of work have changed and because the kinds of jobs open to young people have increased many fold. For example, few boys today can learn occupations from their fathers because most of the fathers do not own their own businesses. Girls today like to study for a career even though nearly all of them expect to marry and devote themselves to a home and family.

As for the number of vocations available, the Department of Labor of the United States Government publishes a Dictionary of Occupational Titles which lists and defines 17,452 different kinds of jobs.

Before choosing a vocation there are things that boys or girls can do themselves that will help them to decide. There is also help that can be obtained easily from others. It is usually wise to have both kinds of help.

The main thing is to think the question through clearly, honestly and systematically. Read the books on vocations in the school or town library, watch the magazines for articles about interesting vocations, and study the catalogs of schools and colleges that train for various kinds of jobs. If your high school shows a series of movies describing different vocations, attend these picture shows.

Your success in school activities may suggest possible future interests. For example, helping to arrange the lighting for a school play may reveal your interest in engineering. If you enjoy writing for the school paper, perhaps you should choose a vocation in publishing or advertising, or radio or a similar field. If you are good at managing school activities, your talents may be toward dealing with people, rather than with cold facts. If you have opportunities to try some real jobs on Saturdays or during the summer, you may find that you are more successful at certain kinds than at others.

Try to analyze your own interests, and think about your abilities as shown by your grades in different subjects. It is more important at your age to decide what your abilities are than to decide upon a particular career for life. For example, are you better at using your hands or at studying from books, or calculating, or writing? Do you like best to work with things or with people?

Get all the help you can from those who are trained to help you. If there is a vocational-guidance teacher or counselor in your school, talk things over with this officer. Usually Scout leaders, clergymen, the principal of the school and other teachers will have something interesting to say, something worth thinking over.

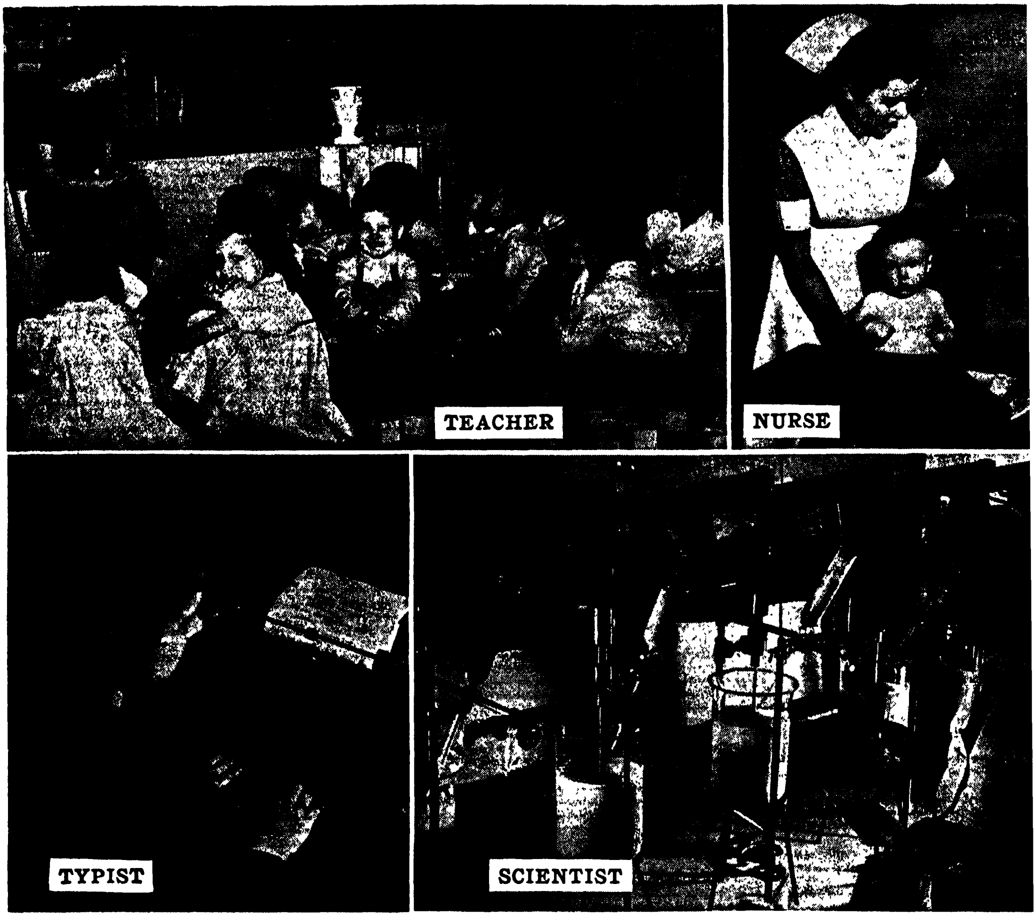
The guidance officer can help in two ways. First, he can give you short tests that have been designed by experts to throw light upon your special interests and abilities. Some people are color-blind. A test can show this. If you are color-blind you should not aim for a vocation where color is important, such as being an artist, or in advertising, or as an airplane pilot. Some people can manipulate their fingers much more easily than others—and a test will show the degree of skill you have. If you are very good, perhaps you should be a musician, typist, skilled mechanic or surgeon.

Various tests can reveal your ability to read easily, to reason in different ways, to think in numbers and to calculate. If you are good in these, perhaps you should aim to go into one of the professions, or to become a scientist, or a business man, or to go into the public service.

Some tests are designed to discover your abilities to do particular kinds of jobs. Other tests help you to discover what your real interests are. Still others are used to show how much you know about particular subjects. Tests such as these were used by the Army, Navy and Air Corps during the war to determine where the men could serve best —whether as pilots, as clerks, as personnel officers, as engineers, as accountants and so on. Although the tests are generally good for these purposes, some kinds are more reliable than others. Usually they need interpretation by an experienced guidance teacher.

Talking over your problems with the school guidance officer will make them more clear in your own mind. The adviser will be able to suggest some vocations that you have not thought about, perhaps some new ones. Furthermore most guidance officers in a school will have lots of pamphlets on hand that describe various job opportunities. Some

Fitting pegs into holes with speed and accuracy, as shown above, demonstrates an aptitude for the kind of skill required to make model airplanes, as the boy is doing at right.

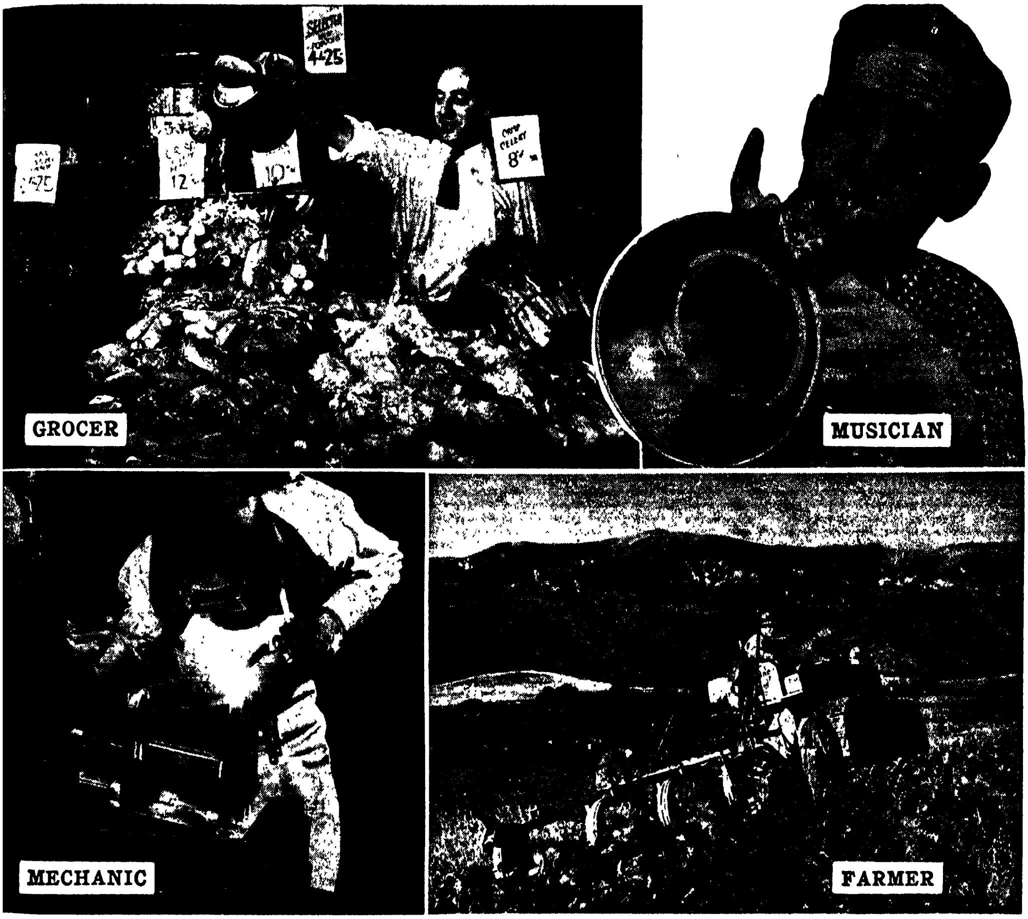


Teacher, Farm Security Administration; nurse, Cornell University—N. Y. Hospital School of Nursing; typist, from All the Children; scientist, E. I. du Pont de Nemours & Co.

of these are based on special studies made by government departments, colleges and private agencies to discover new fields of work and fields that are in special need of trained people. The United States Department of Labor publishes many such bulletins. Industries, professions and training schools also issue bulletins describing certain jobs.

In addition to pamphlets, there are hundreds of movies that can be obtained by your school which tell a picture story of different occupations and businesses. These movies can be obtained by writing to university, state and commercial-film libraries, or to particular companies. One of the best collections, available to schools and other groups for a very small fee, is that of the YMCA Motion Picture Bureau which has offices in New York and other big cities.

When considering a particular vocation, there are a number of things that you should find out about it. These can best be presented through an illustration. In a series of occupational abstracts published by the Occupational Index, Inc., of New York University, New York, there is one on teaching as an occupation. It analyzes the teaching profession from several points of view—the nature of a teacher's work, the classroom teaching as well as the late afternoon and evening work that is not so familiar to the students. It lists the kinds of teachers, classified by types of schools—nursery school, high school, hard-of-hearing school, and college, and by subjects such as mathematics, physical education, printing; the abilities required—intelligence, patience and leadership; the preparation needed to get different

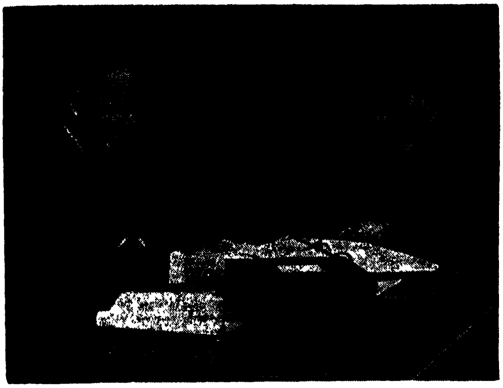


Grocer, Farm Security Administration; musician, Eagle-Picher Co.; mechanic, The Dow Chemical Co.; farmer, Caterpillar Tractor Co.

kinds of positions, the college degrees required and the schools where the training can be secured. It tells the way to apply for a job; the possibility of advancement; the usual salaries paid; the advantages and disadvantages of teaching—stability of jobs, hours of work, pleasant associates, the lack of earnings during the summers, the discrimination against married women and so on. It gives an analysis of the future prospects for teachers, and a suggestion of literature to read for further information. The questions about salaries, vacations, preparation needed, opportunities for advancement, and the advantages and disadvantages of a job should always be considered, whether you are thinking of being a teacher, patternmaker, farmer or lawyer.

But, first of all, ask yourself whether you are interested in the job itself, or whether you think of your life-work in a broader sense. Is the job just a means of earning a living, or is it the means of accomplishing something that you think is worth doing? For example, would you practice law just to earn money, or would you do it to help other people plan their business affairs, manage their properties, or settle personal trouble? Would you think of teaching just for the salary, vacation and security, or as a means of building a better world through education?

A satisfying career gives time away from work for other interests. Will you want to be active in the church and in the community in which you live? What about your desires for recreation, and for family life? Nearly all jobs, of course, have hours and conditions of work that permit these activ-



From All the Children

Wise, helpful advice from a guidance counselor.

ities and interests. A few, however, do not. In any event, when thinking about a job it is well to think also of your other interests and your function as a citizen, as an active member of the community, and as a future partner in raising a family.

A counselor can help you in one other way that may be of particular importance. That is, in a psychological way. Growing up is at best a difficult period with many moments of feeling inferior. Boys and girls are not always pleased with their own abilities or appearance, with their friendships or their entertainment. If you wish things were different in your life, perhaps you can make them different, and thus prepare for happiness ahead. A wise, understanding counselor can put his training and experience at your service. The chances are that he will first make you realize that your troubles are common to most young people; and troubles shared are troubles half cured. Next he will search out the sources of your discontent.

Suppose that you find it hard to read and that you read very slowly. A counselor can give you tests for reading speed and comprehension that will tell you what is wrong. Furthermore, he can tell you how to train yourself to read more rapidly and with better understanding. In some schools and colleges there are reading clinics to improve your ability, just as a course in typing will enable you to type speedily and accurately. Special training in reading is just one of several kinds of specialized training that may increase your ability to do certain kinds of work.

A trained psychologist or a physician or a minister, Scout leader, or teacher can solve many a psychological problem. So do not be afraid to ask for this kind of advice when you think you need it. Be sure to go for advice of this kind to a responsible person. Bad advice is worse than none at all.

What has been said thus far in this description of vocational guidance has been from the point of view of an individual boy or girl. We have pointed out that you should do some planning of your own future life. You should try to pick your career with care and get the training that will promise success. The selection of your life-work should be a matter of choice, not of chance. You will be happier and able to do more for your community, and for the world, if you choose a vocation in line with your interests, aptitudes and abilities. You want also to choose a job that has the best chance to last and one in which you can grow. In making these choices a counselor or guidance officer, interested teacher or adult friend can be of much help.

Vocational and other specialized counseling is a relatively new service. It is given by many schools and colleges to their students as a means of helping a student find the right vocation and get prepared for it. The whole science of testing for aptitudes and deficiencies, and of giving tests of achievement, is a fairly recent development.

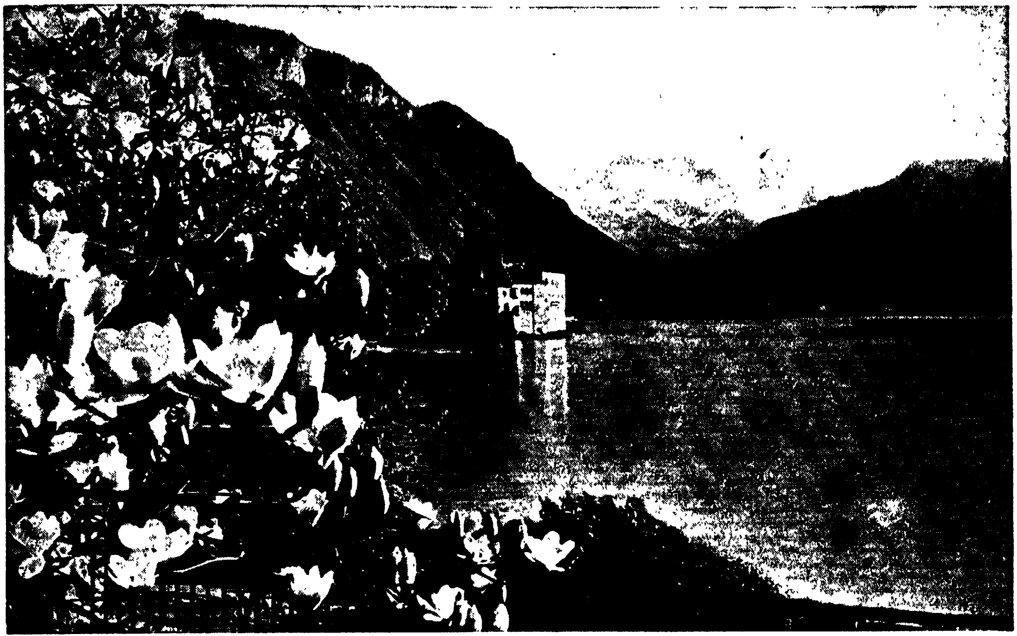
Rapid progress has been made during the past twenty-five years and, although the science is still young, its methods are producing reliable results.

WARTIME EXPERIENCE PROVES THE VALUE OF APTITUDE TESTS

During World War I, for the first time, millions of young men were given standard psychological tests, and some experience was obtained in using them for particular purposes. In World War II, new and additional tests were used with excellent results. For example, the Office of Air Surgeon reported that by using aptitude tests they were able to cut down the number of men who were trying to become pilots from 397 to 155, in order to get 100 graduate pilots. The men whose aptitude tests showed that they were not well qualified to become pilots were spared much wasted time; and millions of dollars were saved.

Choosing a vocation, in our complex world of today, is really an interesting adventure. Never before have there been such a variety and number of fields from which to choose. While this may seem at first glance to make a choice more difficult, it gives you a far greater chance to find a vocation to which you are really suited.

By ALGO D. HENDERSON.



All photos, courtesy Swiss Federal Railroads

The eastern end of the lake of Geneva and the ancient castle of Chillon, famous in history and legend.

SWITZERLAND

THE standing invitation from Switzerland to the nations of the world is: "Boys and girls, come out to play!" They respond very willingly, thousands and thousands of them, not only from the neighboring countries of Germany, France, Italy, Austria, but through them—for Switzerland has no seacoast—from Holland, Great Britain and America; and from almost everywhere else.

We have not far to look to find out the reason why this small country, about half the size of Ireland, is so attractive. The face of Switzerland is very different from the scenery usually before the eyes of dwellers in the cities and villages of our own land. Dazzling white mountains stand out against the bluest of skies; dark forests contrast with bright green meadows down the hillsides, and reach to the shores of wide lakes of ever changing color—purple, blue, green; and into the lakes pour the foaming white rivers.

As we look at these beautiful features on the face of Switzerland we realize what an influence the shape of the country has had in shaping its story. Switzerland can well say, "My face is my fortune," not only because its beauties year by year attract travelers who spend in it an enormous amount of money, but because its protecting and invigorating mountains, its fertile valleys and useful lakes have enabled the Swiss to develop into a sturdy, free, industrious nation.

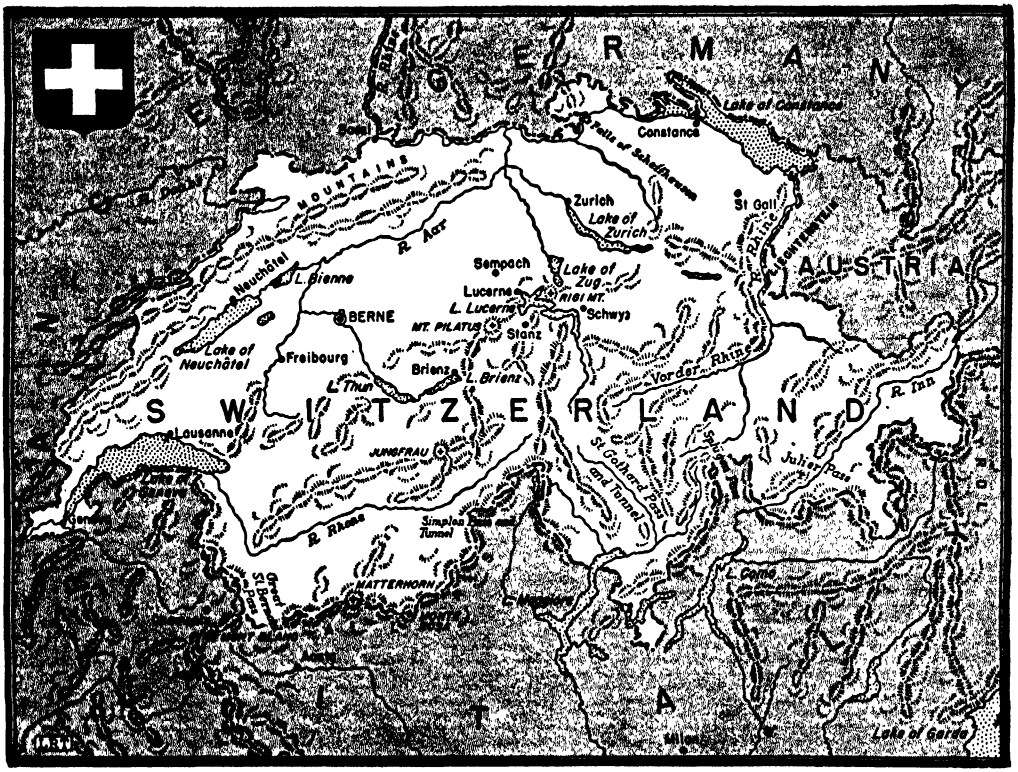
There are today rather more than four millions of Swiss—that is, about half the population of London; but they live independent in the midst of powerful neighbors who have tried to annex their country in times past.

First, let us try to get a clear idea of Switzerland itself. The great solid mass of the Alps, the highest land on the Continent, stretches across Europe from the Rhone to the Danube. Its western end is in France, where, south of Lake Geneva, the highest peak of all, Mont Blanc, rises over fifteen thousand feet. Its eastern end is in the Austrian Tyrol. It is the central part of the great highlands that cover more than half of Switzerland with grand ranges of mountains, the tops of many being above the line of perpetual snow. Among others there are Monte Rosa, nearly as high as Mont Blanc; the Matterhorn, near where Switzerland touches Italy; the Jungfrau, and many more about forty or fifty miles north of the frontier.

Valleys separate the ranges and groups of mountains; some a mere cleft in the bare rocks; some wider, and green with grass and gorgeous with wild flowers in spring and summer; others filled with deep, dark forests.

In nearly all the valleys are leaping and dancing streams. High up, the rivers slide and crawl only a few feet in a year, for they are frozen solid. These glaciers, or rivers of ice, some of them twenty miles long, are the chief wonders of the Alps. Their surface is usually very rough and heaped up, like waves suddenly frozen hard. The edges of the ice, seen in the great cracks called crevasses, are of a vivid blue color, as they are also at the end of the glacier, where the warmer air forces the ice king to loose his grip, and the water escapes on its way to the sea.

Comparatively few of Switzerland's visitors climb over the glaciers and up the highest peaks. It needs strength and endurance to climb in the intense cold, roped to guides, who show the way and cut steps when needed in the ice. But those who do go enjoy it amazingly, so fine is the pure air, so grand are the spacious views and solemn stillness of this white world.



Switzerland sprawls among the peaks and gables of the roof of Europe. From its mountains the rivers flow down in different directions through the neighboring countries to the sea. For example, the Rhone, which flows into the Mediterranean, and the Rhine, which ends in the North Sea, begin quite near each other in the Swiss Alps.

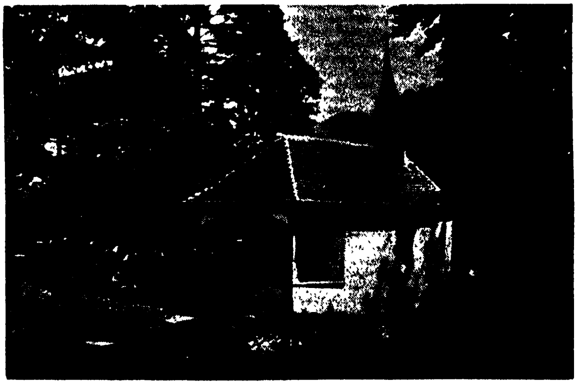
But it is not always white, for at sunrise and sunset in clear weather both sky and snow are bathed in glorious color—rosy red and gold. The stillness, too, is often broken by the thunderous roar of avalanches—masses of snow which slip down the mountain as snow slides off a roof, overwhelming any life that may be below.

Between the High Alps and the plateau of Switzerland there is a beautiful mountainous district which reminds us of our own Rockies, with picturesque rocks and pine woods, and clear blue mountain lakes. In many of the valleys, and round the lakes of Thun, Brienz and Lucerne, thousands of visitors find villages in which to stay. There are even hotels at the tops of some of these mountains, such as the Pilatus and the Rigi, with wonderful railways which climb up the steep mountain sides from the valley below, and are often suspended on cables.

In the plain of Switzerland, which lies between the Alps and the Jura Mountains to the north, are little wooded hills and green slopes, wide fields shaded with fruit trees or richly cultivated with crops of many kinds. The country is covered with towns and villages; everybody is busy, working either in the fields or in the towns at various manufactures. At the southwest of the plain lies the great Lake of Geneva, so large that it takes a fast steamer two hours to go from one end to the other. Geneva is at the south corner near France. At the northeast of the plain is Lake Constance, whose farther shore is in Germany. Between these two largest lakes are many smaller ones, such as those of Neuchâtel, Bienne, Zürich.

The monument at Stans which commemorates the heroic death of Arnold von Winkelried at the battle of Sempach, on July 9, 1386.

All the chief towns of Switzerland lie round the lakes or on the rivers of the plain. These rivers rise within a few miles of each other in a central mountain mass near St. Gothard, and run in different directions. There is the Rhone, rising in a beautiful blue grotto of ice, at the end of the Rhone glacier, and running along a wide and fertile valley to Lake Geneva. It is most interesting to watch the colors of the water pouring into the lake. Soon after leaving the other end of the lake the Rhone passes into France on its southward journey to the Mediterranean.


Each year a service is held in this tiny chapel at Morgarten in memory of the first victorious battle of the three cantons. Uri, Schwyz and Unterwalden, against the Hapsburgs in 1315.

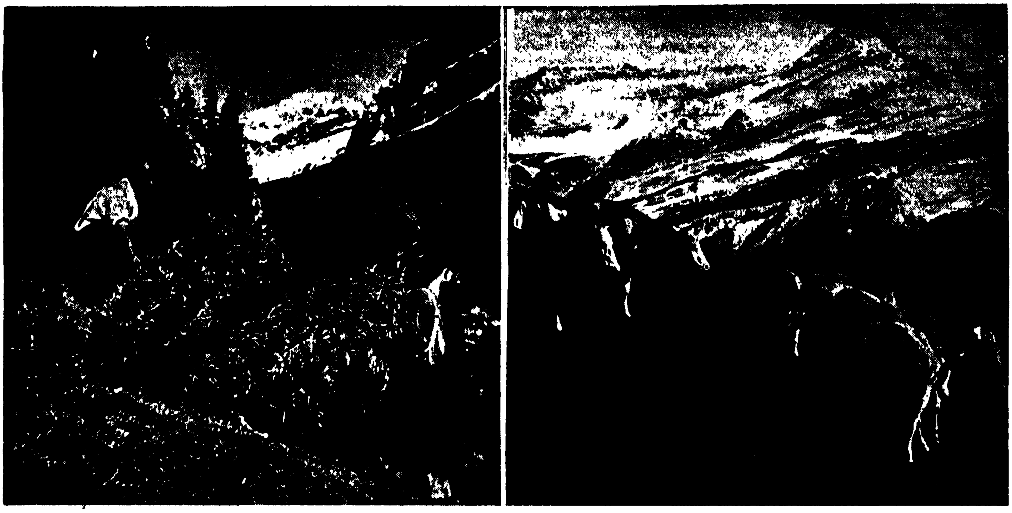
The upper Rhine takes a northeasterly course to Lake Constance, and after leaving it at the farther end, makes the wonderful falls at Schaffhausen, and later, turning north at Basel, becomes the German "Father Rhine." The river Ticino rises near the Rhine, and flows down the south slopes of the Alps, leaving Switzerland as it passes through Lake Maggiore to become a tributary of the Po, the great river of northern Italy.

The river Inn, on its way to join the Danube, rises not far from the Rhine. Another important Swiss river is the Aar, which rises near the Rhone and flows through Brienz and Thun, then along a winding course to the Rhine. Bern, the capital of Switzerland, is on the Aar.

In the Museum of Bern there is a deeply interesting model of a settlement built on a lake. It shows us how piles were driven into a soft shore where the water was shallow; how a floor of wood was fastened above the piles; and how, on this floor, the huts were built of wood and hurdles, and roofed with rushes. There was a gangway easily removed to connect with the shore.

As far as we know, the people who lived in these lake-dwellings were the earliest to settle in the country. At any rate, it is believed that their times date back to a thousand years before Christ. Life was very wild then in central Europe, and it is supposed that men made their homes in this fashion to get out of the way of wild animals and also out of the way of wild neighbors.

We should know very little about the lives of these Swiss lake-dwellers if their possessions had not been preserved by fire. This may sound very strange indeed, but when the flames were consuming these

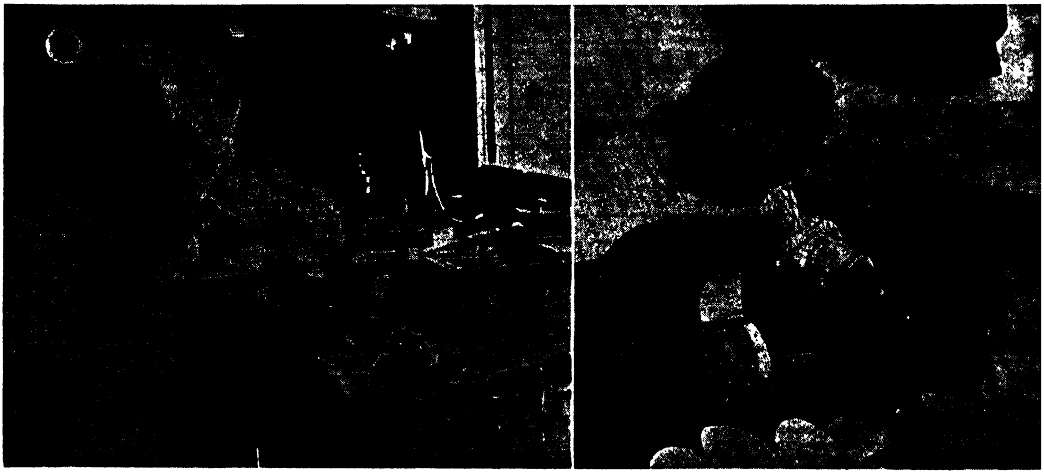


Dairying and haymaking are carried on in steep Alpine meadows. In the spring the cows are taken to the high upland pastures, and in the autumn they are brought home where hay can be provided for them to eat during the long winter months. The men at the left are laboriously dragging bundles of hay down to be stored.

old homes the remains became crusted with charcoal as they fell into the soft bed of the lake beneath, and so were kept safely.

And so we can see today the nets, the blackened stones, the raspberry seeds and ears of corn, the fishing boat and hooks, the pottery, small mugs for the children, and tiny bracelets for their arms, among many other things that make this far-away time quite real to us.

The next race of men who made their home in the plain of what we now call Switzerland were the Celts, in many ways like those who lived in Britain. They were very brave and warlike, fond of ornaments and fine armor, and were led by Druid priests. Gradually they were subdued by the all-powerful Romans, who adopted the same plans as they did later in Britain. Fine roads were made across the high passes of



Switzerland is famous for its skilled craftsmen, including makers of clocks and watches, weavers, wood-carvers and others. The man at the left is a watchmaker of Geneva, a city famous all over the world for its watches. At the right is an old man of Lugano who is skilled in the making of the zoccolis, or wooden shoes, which many of his fellow-countrymen wear. Like many other expert handicraftsmen, he carries on his work in his own home.

the Alps from Italy to the towns established in the plain under Roman rule.

Two chief roads were over the St. Bernard Pass and the Julier Pass—where there are still two milestones of Augustus Caesar, in whose reign Christ was born. In the museums of all the large towns of Switzerland are many remains of the conquerors of the Helvetians, as the chief of the Celtic tribes were called. Along the beautiful and sheltered shores of Lake Geneva the rich Romans had fine villas and to this day there are ruins of buildings belonging to the Roman times.

East Switzerland was never so thoroughly Romanized and subdued as the western part. Hence, when the German tribes succeeded at last in settling in the country—the power of Rome had died out—the Alemanni in the northeast entirely absorbed the Celts who lived there, and who had but little power of resistance, and planted a true German people, with their own laws, language, manners and customs.

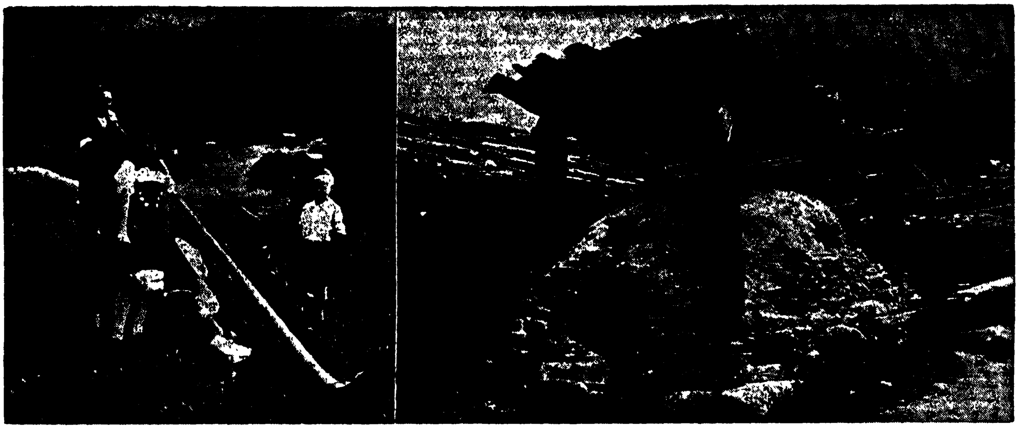
With the Burgundians—also a German tribe, who settled in the southwest—it was different. The newcomers brought fresh vigor into the country, but were influenced by the civilization of the Romanized Celts, and were gradually blended with the earlier settlers, thus forming a new people, the foundation of whose speech was Latin. This was the beginning of a German speech and a Latin speech, which developed into French, being spoken side by side in this little central country. The larger eastern part still speaks German, and the smaller western part speaks French. Where the south border now runs down into Italy the people speak Italian. About 45,000 Swiss speak an ancient tongue called Romansh, of Latin origin. It became the official fourth national language of Switzerland in 1937.

Switzerland has many quaint road signs, carved in wood, like this one which points the way to the harbor. Many of these are made at Brienz, a wood-carving center.

For long years the two races were at war with each other; then both were subdued by the Franks, who governed by their officers and counts. The great Charlemagne, whose dominions extended from Spain to Hungary, from Denmark to Rome, spent much time in Switzerland.

Many great monasteries and abbeys were founded or made more important in Charle-

Weaving and cheese-making are important industries in the Bernese Oberland. The loom in the picture was built in 1812, as you may see from the date carved on the crossbeam just above the weaver's head. To the right we see farmers dividing the cheese that has been made from the milk of the village herds. Each farmer's share is decided according to the number of cows that he sent up to the pasture. Some have many cows, others have just one or two.



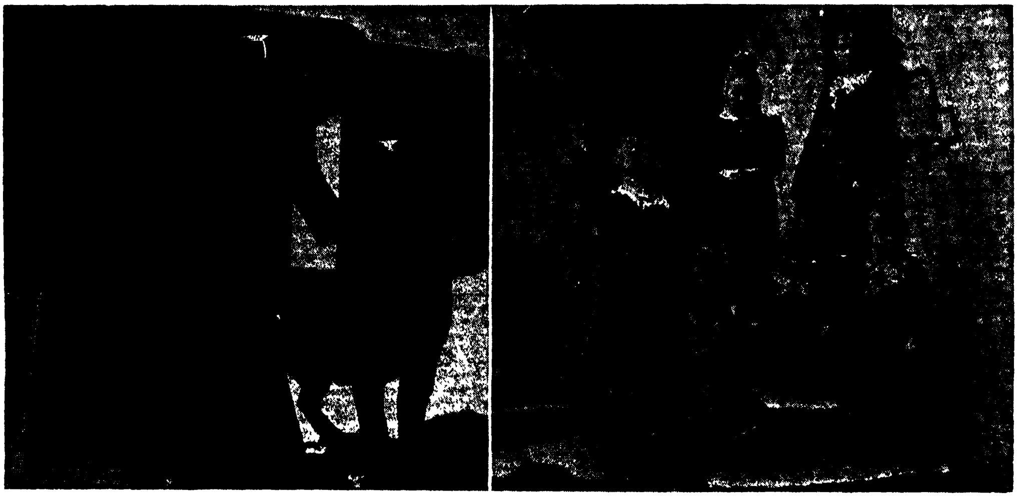
Switzerland has much that is new and modern, but tourists are always more interested in the quaint and colorful survivals of the past, such as the Alpine horn in the picture at the left. To the right is a primitive community baking oven. It has space for about twenty loaves of the bread that the peasants make of rye flour.

magne's day. One was that of St. Gall, founded by an Irish missionary, in which learning was carried on and valuable books were written and collected during the years of warfare and trouble which distracted the country. At St. Gall, now one of the chief industrial towns of Switzerland, many of these old manuscripts are still to be seen.

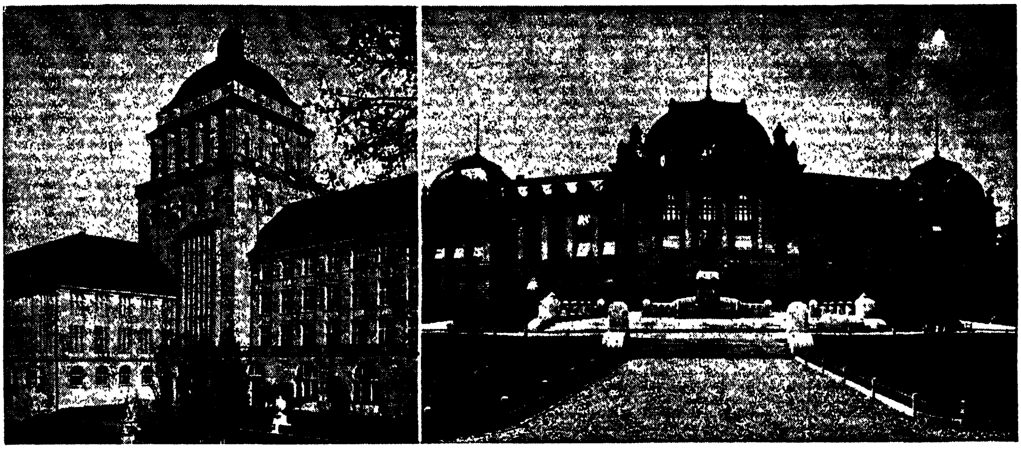
When Charlemagne's dominions were divided, the east and west divisions of what is now Switzerland fell apart again, boundaries and rulers were constantly changing, and the people had a desperate struggle to keep any of the old rights so dear to their hearts. Powerful churchmen, and great families who had secured large grants of land, all managed to destroy the liberties of those who lived on the soil.

When the German emperors took possession of the country they governed by nobles, who became more and more powerful as the power of the Holy Roman Empire declined.

It was the growth of free towns that helped the people to resist their lords. These towns were walled in, and they had charters which gave them freedom to trade and make money, like the free towns of Germany. Fribourg and Bern date from the twelfth



The famous hospice of St. Bernard was founded in 962 at a pass high up in the Alps. For centuries the monks of the hospice have bred the wonderful St. Bernard dogs who are trained to find and rescue travelers who have become lost in the snow. At the left a monk is talking to one of the famous dogs. The six girls of different sizes and ages in the picture at the right are bridesmaids. In their quaint costumes they are all ready for the wedding.



Two of Switzerland's famous universities. Zurich, at the left, is a modern institution, founded in 1832. The University of Bern, at the right, has had its real growth since it was reorganized in 1834, and is now a state institution, but it was a center of learning before that. During the Middle Ages it was a small local school.

century, and in their fine old buildings and handsome fountains we have many reminders of the far past.

In the next century comes the rise of the Hapsburg family, from among a crowd of nobles on Swiss soil, all trying by conquest, marriage, purchase of lands or unjust takings to get the lead. Rudolph of Hapsburg rose to be German emperor. In Switzerland he waged war with Bern, forced lands from nobles and abbots, and seized farms and estates; and his heavy hand was felt all over the country. Perhaps because it was so heavy, the people resolved to bear it no longer. Anyway, the love of freedom seemed to revive, and the determination of the people raised an enduring obstacle to the rule of the Hapsburgs.

One of the tributaries which make the Aar so large and full when it joins the Rhine is the Reuss. Leaping down the rough sides of the St. Gothard, it passes on through a long, narrow lake with many branching armlets, and out at the farther end with rapid swing, past the beautiful old town of Lucerne. It was round the shores of the Lake of Lucerne—sometimes called the Lake of the Four Cantons, because four cantons, or counties, share its shores—that the brilliant struggle for Swiss independence was carried on in the thirteenth and fourteenth centuries against the tyranny of the Hapsburgs.

Three out of the four cantons formed a league. They were Schwyz, Unterwalden and Uri; it is from Schwyz that the name Switzerland comes. The men who lived in these three famous cantons were descendants of the freedom-loving Alemanni, and for them the lake was a common outlet and rallying place. Their towering mountains and valleys, hidden away from the rest of the world, had kept them distinct and self-reliant, and their bodies were hardy from the perpetual struggle to make their living under difficulties; their spirits were bold and fearless from constant contact with danger, which each had to meet for himself. Added to this was the intense love of country which makes brave men dare anything. When once we see this glorious country, its towering mountains, its frowning rocks, its widespread forests, its lovely green slopes, its orchards and meadows, and the unspeakable beauty of the lake with its soft blue distances and deep shadows, it is easy to understand the patriotism of the three forest cantons.

Many of the romantic stories that have been handed down through the centuries about these times are now considered untrue; but they are so firmly imbedded in the country's story, and illustrate in such a graphic way the spirit of the times when the union of the states was taking place against a powerful enemy, that we still love them. One of the stories tells how, on a green meadow above the Uri branch of the lake, three patriots who had suffered greatly from Hapsburg rule met in the still, dark nights to talk over their wrongs, and vowed to free their country from oppressors. Friends joined them, till the band became thirty-three. As these men raised their right hands to heaven, making covenant together, "One for all, and all for

Grimsel reservoir and dam in the Bernese Oberland.

one," the sun shot its first cheering rays over the mountain tops, and seemed to promise success. The three men of Ruetli (Ruetli meaning the "secret meadow") have long been national heroes of the Swiss.

The romantic story of William Tell, who shot the apple from his son's head is told elsewhere in our book. (See Index.) All over Switzerland are statues and pictures to illustrate the act. One of the most beautiful poems of Schiller has spread the story, or legend, of William Tell all over the world.

In 1315 the spirit of resistance to the Hapsburgs led to the great battle of Morgarten, and this victory began a series of successes which for two centuries increased the feeling of union. At Morgarten the large Austrian army was overwhelmed and destroyed in a narrow pass by the mountaineers, few in number. They lay in wait on the heights and at the right moment hurled down on their foes stones, rocks and trunks of trees. Then the main body of the men of Schwyz and Uri rushed like a whirlwind down the hill on the terrified Austrians.

Some seventy years later the Austrians were again defeated. The battle of Sempach is famous for the bravery of Arnold von Winkelried, who gathered the spears of the foe to his breast. There is a fine monument to Winkelried at Stans, in Unterwalden.

Toward the middle of the fifteenth century there were eight cantons joined in union, and such was their power that they succeeded in getting the better, not only of the Austrian Hapsburgs, but also of the Duke of Burgundy, who harassed the west side of Switzerland nearest to France. At last the unity and bravery of the Swiss succeeded in making their independence secure, though in name they were attached to Austria till the Peace of Westphalia, in 1648, which ended the Thirty Years' War.

Switzerland had its own Reformation about the beginning of the sixteenth century. Large numbers of the people listened to the teaching of the reformer Zwingli and others, and left the Church of Rome. Ulrich Zwingli, who was born on New Year's Day in 1484 and died in the autumn of 1531, gained his power over the people by his bold preaching. He introduced the doctrines of the Reformation before they were advanced by Luther. Eventually war arose between the Roman Catholics of the forest cantons and the followers of Zwingli in Zürich, and in 1531, at the battle of Cappel, where the men of Zürich numbered only one to four, Zwingli himself was slain. Unhappily, bitter feelings between the Roman Catholic and the Protestant cantons brought about long civil wars before religious freedom was gained.

Switzerland shared in the progress of those times when people began to care for study and art. The little country has reason to be proud of its writers and scholars, and the artists who have left such beautiful work behind for later times in the stained glass, wonderful carvings and painted tiles still to be seen. Refugees from religious persecution in other countries did much to foster trade and industries, especially the weaving of linen and silk. But, despite all this prosperity, a time of decline set in.

SWISS SOLDIERS FOUGHT IN THE ARMIES OF MANY LANDS

The deeds of daring and courage which led to the rise of the Swiss people spread their military fame over Europe, and Swiss soldiers were eagerly sought after and hired for pay to fight in other armies, especially in France. This was bad for the independent nation.

Again, the influence of the despotic Louis XIV spread over Switzerland as it did over Germany, and the spirit of absolute rule led to the peasants' being ground down and deprived of their rights, while the governing classes indulged in luxury. There were many grievous risings, and the country was in a sad plight when the cry of the French Revolution, "Liberty, Equality, Fraternity,"

A daring climber tries his skill in a crevasse of the Gamchi Glacier. In such dangerous climbs as this the climbers are roped together so that if one slips the others can hold him.

Skiing down the snow-covered slopes of Adelboden in the Bernese Oberland is a thrilling sport which attracts many ski experts.

spread, echoing over the mountains and plain of Switzerland.

When Napoleon turned Europe upside down, Switzerland could not escape. French armies, often fiercely resisted, passed through the cities, across the plain, over the snowy mountains at will. Napoleon made grand roads—that over the Simplon Pass is a wonder of the world—as Caesar had done centuries before, and seized Swiss money and treasures. Then Napoleon turned the country into the Helvetic Republic, under his own eye. The Swiss naturally hated the pounding of the cantons into one state, and the old spirit of bravery and resistance flashed out again and again.

But it was not till after the Battle of the Nations at Leipzig that the weight of Napoleon's hand was removed. The Swiss were far from satisfied with the arrangements made at the Congress of Vienna. Many changes had to be lived through in the years of the nineteenth century before the twenty-two cantons settled down to a federal union, perhaps the freest and most representative in the world.

The Swiss are great believers in education, and their arrangements for teaching reach to the poorest child in the remotest valley. Pestalozzi was one of the great leaders in improving education, and his influence has spread far beyond Switzerland. John Henry Pestalozzi thought out the principles of education with care and originality, and put them directly into practice himself; but he was a thoroughly unpractical man in the ordinary affairs of life, and his management of a school always collapsed because he could not organize it in a business-like way. None the less, he attracted wide attention by his methods of teaching, and they are still studied with interest. Born at Zürich, he lived from 1746 to 1827.

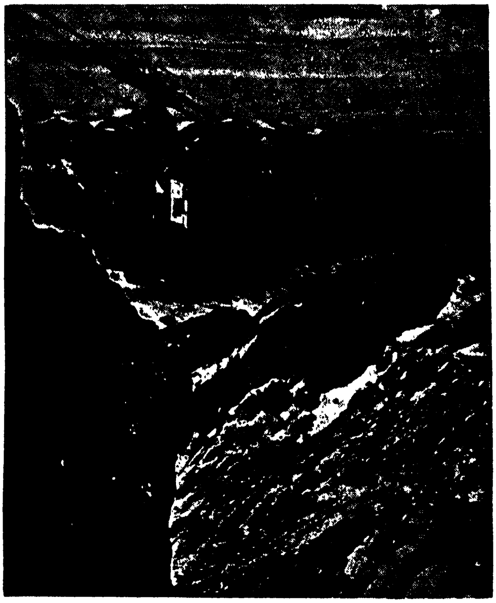
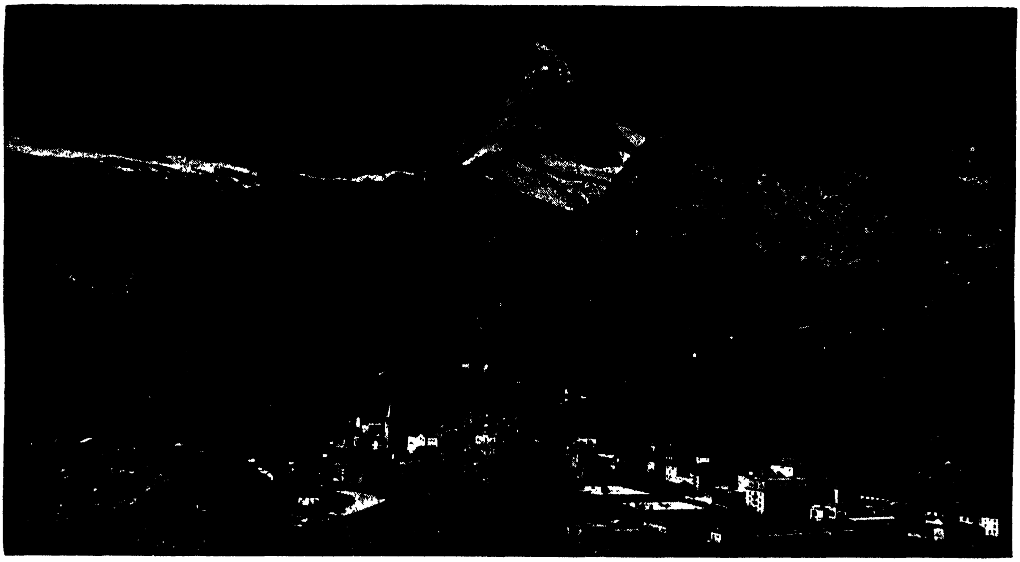


Photo by Hans Gross

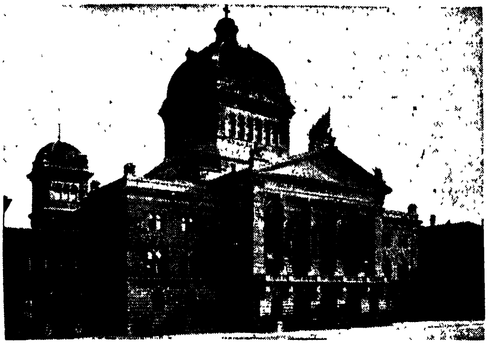
The aerial railway up to the Säntis, in Appenzell.



Zermatt is a charming town in the Velais. It nestles in a valley like an emerald cup. All around it rise the rocky hills and beyond stands the Matterhorn's snow-capped peak, like a never sleeping guardian of the town.

Great attention is given also in Switzerland to teaching trades of all kinds, and since the introduction of machinery Swiss industries have increased marvelously. Water power in the leaping torrents from the mountains is turned to use in sawmills and other factories. Every village, even the most remote, has electricity for lighting and power, and the telephone is available for all. Early last century in the cloisters of the famous St. Gall Monastery arose the hum of spinning, and in Zürich and the neighborhood

An electric train passing over the Pianotondo Viaduct near Giornico, south of the famous St. Gothard tunnel.



The Parliamentary Building is the main structure of the Federal Palace at Bern, the Swiss capital.

began the cotton and embroidery manufactures now so famous all over the world. The production of silk goods holds its own at Zürich and Basel, and at Neuchâtel and Geneva are made watches and music boxes.

Bern, the capital of the country, has a population of about 130,331 people, and is the third town in size. Zürich, with 336,395, is a great industrial and educational center. Basel, in the north, 162,105, is the railway center of the country. Geneva, in the south, has about 124,431 inhabitants, many of these being foreigners. Other towns with over 40,000 people are: St. Gall, 62,530; Lausanne, an educational center, 92,541; Winterthur, an engineering town, 58,883; and Lucerne, 54,716.

All round the borders of Switzerland trains now bring in the coal and raw materials needed by this industrious country, and carry away its finished work. Switzerland has also to obtain from abroad much grain, as well as coffee, rice, eggs and other foods.

The lines which pass into Italy depend on the wonderful tunnels that have been made through the masses of the Alps. The Mont Cenis Tunnel is in the French Alps. The St. Gothard Tunnel is rather longer, and the Simplon Tunnel is twelve and a quarter miles long. The Arlberg Tunnel connects northern Switzerland with the Tyrol. The engineering of all these Alpine railways is most wonderful, not only in the matter of tunnels, where workmen starting from the two ends met in the middle of the mountain, but also in the loop railways, and the numberless mountain lines that climb over passes, and up steep inclines to heights often above the clouds.

It is delightful to get a peep into the life of the mountain folk, to see them taking charge of the herds of cows with their tinkling bells; making cheeses in the little huts; carrying down an immense weight of them to sell in the markets below. Every little scrap of land is made the most of, and even little bits of hay are collected in a net and carried to the loft to be stored for winter. For, as the cold and snow come on, the cattle are driven down from the heights when there is nothing for them to eat; with much lowing and jingling of bells they come down.

A large trade in condensed milk is carried on in Switzerland, and the milk of Swiss cows is also used in chocolate-making. In the winter many of the mountaineers carve little animals, chiefly bears, like those to be seen in the pit at Bern. They make also little model chalets such as they live in themselves, with stones on the roof, to keep it on in the stormy winds. They are very clever at making flowers and other delicate things out of ivory.

GENEVA'S FLAG HAS BECOME A FLAG OF PEACE

It was at Geneva that the Red Cross was formed in 1861, the principle being accepted by all nations gathered there that nations at war should never fire on ambulances or hospitals, with nurses and doctors who are caring for the wounded, under a Red Cross flag. That is the flag of Geneva. The flag of all Switzerland is a white cross on a red ground.

During both world wars Switzerland was neutral. Her policy is to remain neutral unless attacked. However, the Swiss gave aid to the wounded and to prisoners, children, refugees and the families of missing persons. After World War I Geneva was made the headquarters of the League of Nations.

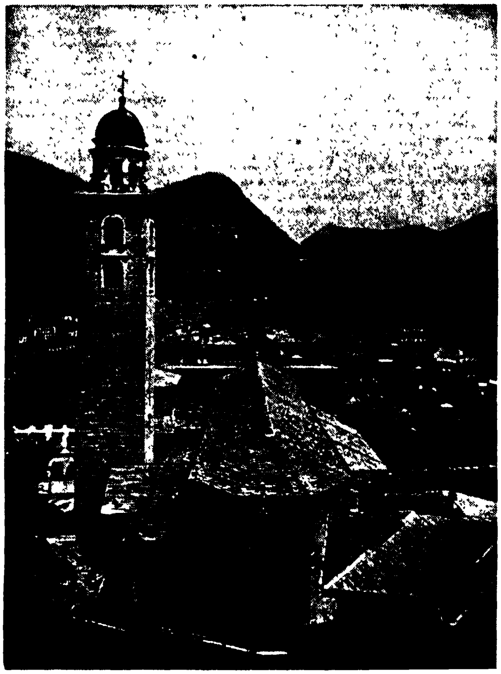
Each of the cantons has local government of a kind devised by itself, but all the cantons join in a general government for the Confederation. This federal government regulates war, peace and treaties; the army, railway, post, coinage, and weights and measures; bankruptcy, patents, precautions against epidemics, public works on a national scale, and largely education. Other public affairs are treated as local.

The Swiss Parliament consists of two chambers, a State Council of 44 members, two from each canton, and a National Council of 194 members, one for every 22,000 of the population. Elections take place every four years. Every man has a vote in his twenty-first year, and any voter may be elected. No other country in the world is as thoroughly democratic as Switzerland.

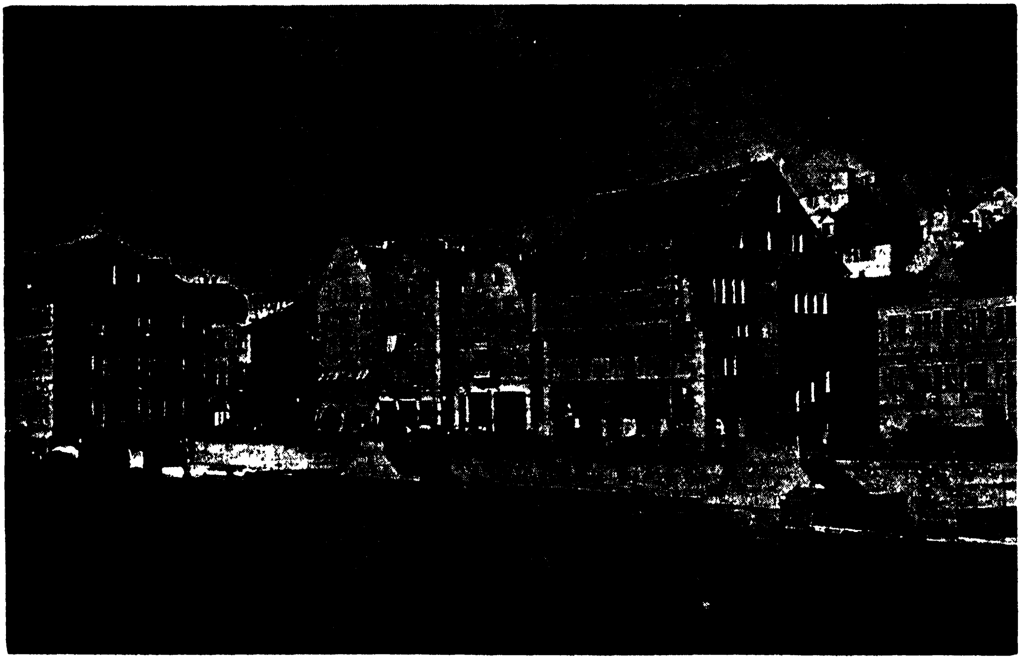
. The electors can introduce legislation into the Parliament directly if 50,000 of them demand it. They can also object to any law passed by the Government by sending in a petition of 30,000 citizens. Then a direct vote of the whole nation must be taken, and if there is a majority of the electors and also a majority of the cantons against the law, it may be vetoed or amended. This supervision of laws by the people direct is called the referendum.

The executive authority is a council of seven members elected for four years by the Parliament. Its members may not hold any other office or do any other business. The president and vice-president are elected by the whole Parliament for one year. These supreme officials are usually business men who have won general confidence, and the spirit of this most democratic of all governments is one of modest simplicity with business efficiency. It may often happen that the president of Switzerland is to be found opening the door of his small house to a caller, or receiving visitors in his shop or his office.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 6132.

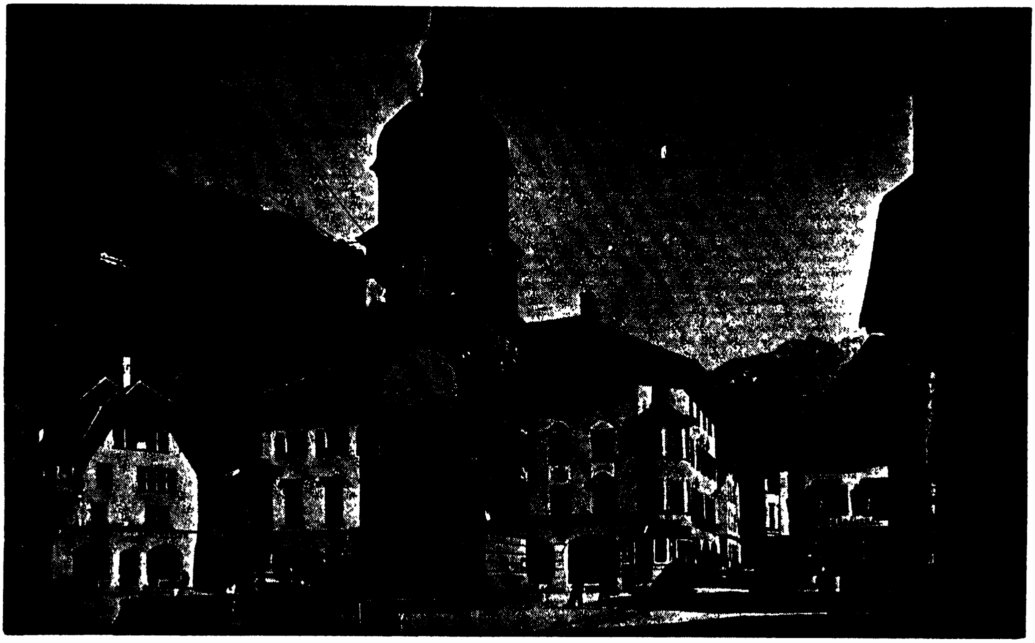


Looking down on Lugano, in southern Switzerland, its roofs and towers clustered around the margin of Lake Lugano. In the foreground of the picture is the ancient cathedral of San Lorenzo.

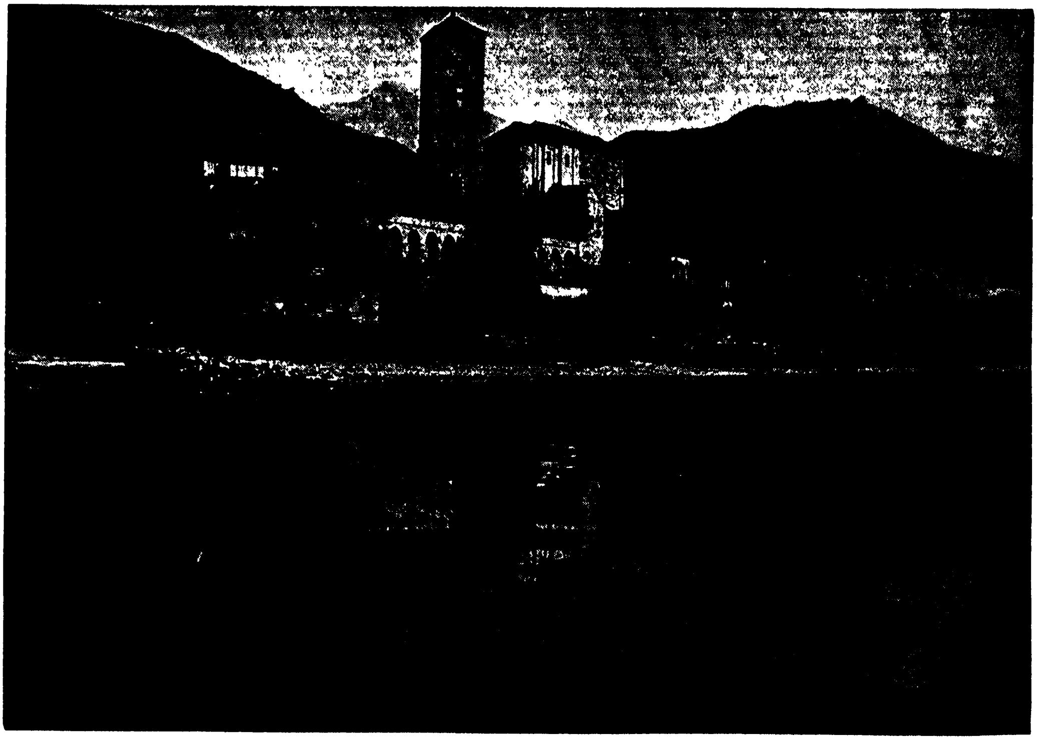


Along the banks of the Limmat River which flows through the ancient city of Zurich, you might think you were in a northern Venice. Zurich still has a few medieval buildings, like the one in this picture with the arcade.

SCENES OF SWISS LEGEND AND HISTORY

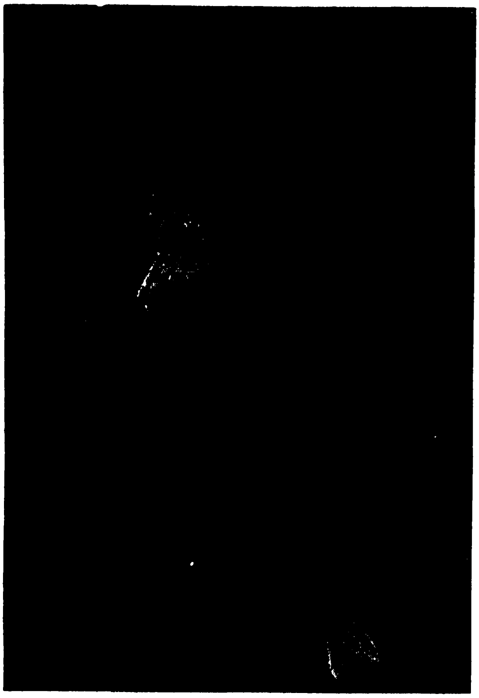


William Tell and his brave deeds are commemorated in Tell Square in historic Altdorf on the Lake of Lucerne.

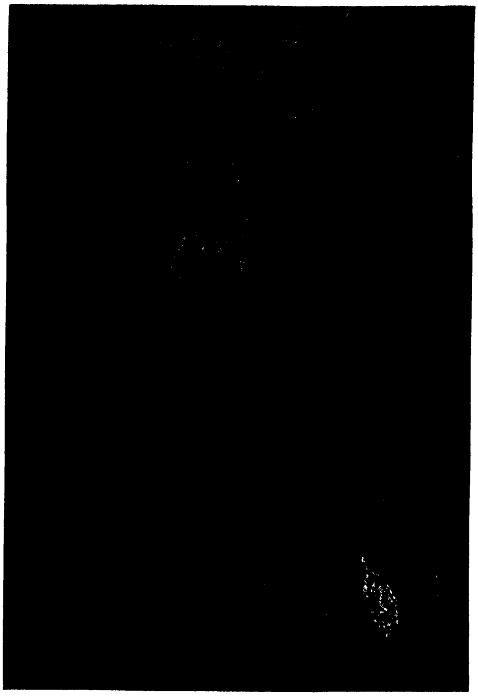


The shores of Lake Maggiore, near Locarno, where a famous conference to secure world peace was held in 1925.

"WILL YOU WALK INTO MY PARLOR?"

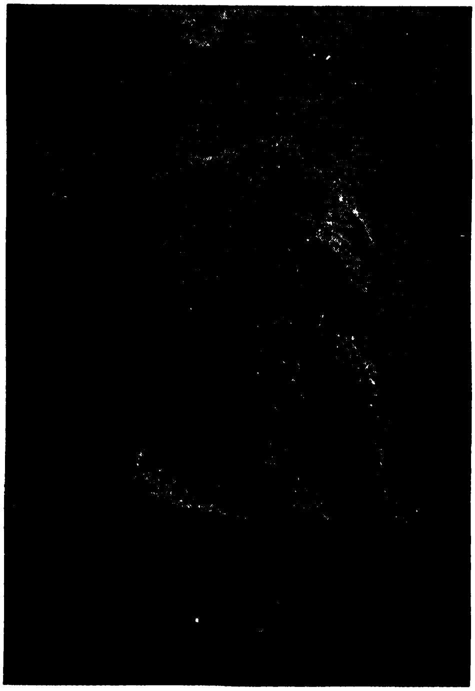


The spider looks out upon the world and sees the fly approaching.



The spider wraps up the fly in a web blanket and returns to the middle of the web.

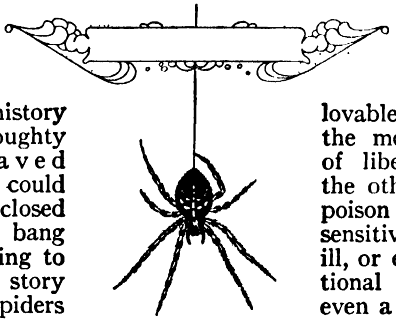
After ten minutes the spider visits his prey, cuts the threads and takes it back.



The spider carries his victim to his den, where he banquets at leisure.

The Water Spider, an interesting European creature, takes a bubble of air to its home in a pool.

LITTLE MANY-LEGS



In the old days when those heroes of romance and chivalry of whom we read in history were still living, a doughty warrior who had braved every peril which he could imagine would have closed this chapter with a bang and have crept trembling to bed. For our present story is about scorpions and spiders and some other things of ill-fame even in our own day. In former times their reputation was worse. Our forefathers down to Shakespeare's time, and far later, believed in dragons and fire-breathing basilisks. They thought that as scorpions ate venomous things to increase the power of their own venom, so these fabulous creatures lunched on scorpions to add to the intensity of their own evil poisons.

The Old Testament teems with references to scorpions. Later, terrible tales were told. There were scorpions that stung young girls to death on sight, and caused the lingering death of women. Others ate men. Still others had feathers and flew afar to their mischief. Some scorpions had such a hatred toward men that they would mount to the ceiling and hang, one from another, five or six deep, merely for the evil delight of inflicting a mortal wound.

The truth is that scorpions, spiders and their allies, while not exactly lovable creatures, are, for the most part, the victims of libel. The one stings, the other bites. Both have poison which may make a sensitive and nervous victim ill, or even kill in an exceptional case. But a shock, even a suggestion, may have that result in a rare instance, where neither scorpion nor spider is within a hundred miles.

Scorpions have their unpleasant aspect, undoubtedly, but it is wrong and foolish to overstate the case against them. They, like the spiders, feed upon insects and other small creatures, taking the good—according to man's ideas—with the bad, but having no desire to harm man.

If the Order were nearly as fatal to human fortunes as these old beliefs represented, there would be no human family in existence. Scorpions are almost as old as the hills. Their lungs are quite different from the lungs of mammals, and resemble in some ways the gills of a fish.

The arrangement of these organs is suggested by their name—lung-books. They communicate with the atmosphere through narrow openings, and are composed of a number of thin projections, like the leaves of a book. The blood circulates through these, comes in contact with the air, and so is purified. Therefore the scorpion and its allies are able to live in the atmosphere as we are.

Like all the arachnids, to which they belong, scorpions have no neck. The head is really part of the thorax. Two pairs of appendages spring from the head. There is a small pincer on each side of the mouth called the chelicera. Behind these is a formidable pair of pincer claws which serve to grasp prey. They then act as jaws to tear and rend it in readiness for the mouth, which sucks the juices from the mangled fragments of a victim. Four pairs of clawed legs arise from the hinder part of the chest. Insects have only three such pairs.

A QUEER OLD BELIEF ABOUT THE DAINTY FORGET-ME-NOT

Whenever we look on the dainty forget-me-not let us recall its old-time name in England—scorpion grass. It was anciently believed there that if people used scorpion grass they would have no need to fear the sting of a scorpion. And truly they were right, as far as England was concerned, even if they did not call scorpion grass to their aid, for, as far as we know, there never were any scorpions in that country. Scorpions are fairly widely scattered about the earth, and abound in Southern Europe as well as in southern United States.

Temperature, rather than light, is the main requisite. Though scorpions have three or four pairs of eyes, they see but dimly, and come out to hunt only at dusk. Touch and smell are their guiding instincts, and both faculties reside, apparently, in the great pincer-like claws which we call the pedipalps. Nothing more than two or three inches away is visible to a scorpion. Experiment has shown that the creature will run partly over a cockroach without discovering it till its sensitive feelers touch it. Then it will draw back and eat the booty just discovered.

The great lobster-like claws are carried in front of the head. They are not used for walking, nor do they have any share in the digging of the sandy home, for this is the work of the legs, with the tail to sweep away the accumulated débris. The pedipalps, then, sense and grip objects. If the prey is small, the claws do the whole business of slaughter. A larger victim, however, is firmly grasped and held, while the tail is curved over the back and the sting brought down and introduced. After that there is no resistance: the little monster eats his meal.

THE TERRIBLE LITTLE CREATURE WHICH RUNS AWAY FROM LIGHT

Generally scorpions avoid human beings, and they run anywhere for seclusion from light. They delight in creeping into beds, shoes and clothes, so that when we get into a bed or put on our garments in the tropics we may be invading the place which a scorpion has chosen in which to hide away from the daylight.

Then, if we are not frightened by the threat of his angry pincers, he applies his poison-oozing sting, causing violent pain and sickness. There are nervous weaklings who die with the bite of a small snake or a big spider. The same type of temperament may collapse under the shock of a scorpion bite. Hence the indictment of which the poor scorpion can never prove himself guiltless.

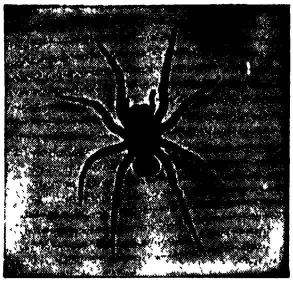
The natural prey of the scorpion consists of spiders, insects that live on the ground, and, from time to time, small frogs and even tiny mice. Agile, elusive creatures all these, it will be noticed, for an assailant which does not readily detect prey at a distance. True, but the creatures caught by the scorpion are not all keener of sight than their captor. If the day's hunting proves unsuccessful, the scorpion can bear it. Northern kinds fast during the winter season, though alive and alert as the wintering crayfish.

THE OLD NATURALIST SPENT MONTHS WATCHING SCORPIONS

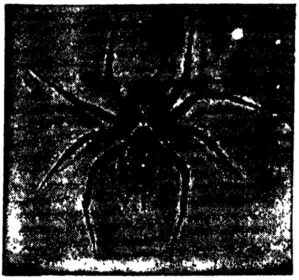
One item of diet has to be added. It is scorpion! The courting season often ends in tragedy. Before the wedding the males woo most ardently. The naturalist Henri Fabre devoted months to watching them in France, and we owe much of our knowledge to his writings. The little male seizes a buxom female greatly his superior in size and power. With their hideous faces brought into contact, they exchange what a scorpion poet might dignify with the name of a kiss.

Then off they prance, the male grasping the female's claws. He walks backward, leading or gently dragging his mate after him. They may promenade for hours, even for days, in this way, till finally he induces her to approach a burrow which he has made.

A LITTLE COMPANY OF SPIDERS

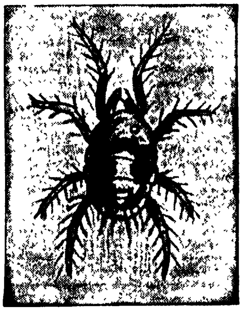

European tarantula.

Garden spider.

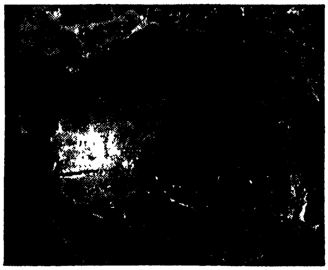

Wolf spider.

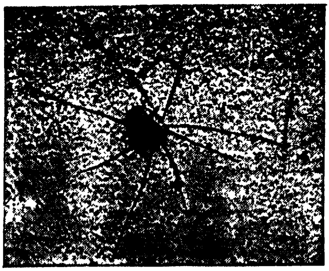
A bird-eating spider in search of prey.

House spider.


Red mite.

A South American trap-door spider.


The home of the house spider.


Common harvestman.

Nest of a trap-door spider.

The pictures on these pages are by Mrs. M. H. Crawford, Messrs. Berridge, Collins, Johnson, Ward and others.

THE CANNIBAL BRIDE WHO DINES ON HER BRIDEGROOM

But the result is never in doubt. Once the female accepts the home and fortune presented by the male the end is in sight. She enters, settles down, and dines—on her bridegroom. But he is not stung to death—merely eaten. Scorpion poison is not harmful to scorpions. There is an old tale that the scorpion sometimes stings itself to death. Nonsense!

Eight inches is the greatest length to which scorpions are known to attain. Three inches is about the average for adults outside of the tropics. The tales of their eating men and other victims of bulk are as ridiculous as that they are winged and feathered. Even so, they have sufficient terrors for nervous folk who find them sharing their socks.

THE WONDERFUL SILK OF THE WORLD'S FIRST SPINNERS

What has the Spider world to show in comparison with the petty villainies of the scorpions? Spiders have their poison, though not a sting; they are as voracious, in their way, as the scorpions in theirs. But though they come boldly into our daily lives, they do not inspire the fear among people in general which undying tradition has created in connection with their stinging cousins.

Really we ought to approach the spiders with more of marveling than of repulsion. They were among the world's first aeronauts, first builders, first engineers, first spinners and weavers. How they originally succeeded in converting food into a natural glue which on entering the air instantly becomes silk, we shall never be able to find out.

But there it is. A man of the wilds faced by a wide, steep chasm is defeated unless he can climb like a goat. Even goats cannot scale precipices. A spider is our master in the matter. He cocks up his spinnerets and squeezes out a number of tiny jets of material looking to the eye like a dark-colored gum from a mistletoe berry. As they emerge, the jets unite into one splendid strand of silk, stronger, in proportion to size and weight, than the finest steel ever compounded.

The strand grows and grows under the effort of the spider. It floats off into the air and has its gummy end caught on a distant projection. Across this tight rope, this natural bridge, spun from its own body, the spider proceeds in triumph to the conquest of a new world.

THE AGE-OLD MYSTERY OF THE BABY SPIDER'S LONG FAST

That is the magic of the adult; the baby spider has a feat at command not less astonishing. In some species the mother attends to her eggs and to her babies when they are born, and carries the little things about with her. They ride on her back, guarded, transported, snugly housed; but fed—never! They reside on her body, fasting week after week for seven or eight months, without one particle of food or one drop of moisture.

How do they sustain life, strength and growth under such extraordinary hardships? The active sport and play in which they seem to indulge consume energy; their growth demands more; yet they take in no fuel to replenish their engines of life. Here is a mystery which is unsolved to this day. But the time comes when their cycle of baby life is run. Their call comes to quit the mother. She lets them go without regret, as a hen beats away the chickens which she has cherished for a month or more. She would eat them if they tarried longer.

Their guardian angel now becomes a consuming dragon to the little spiders. They fly from her, not actually, but in such a manner as to suggest the comparison. They climb to the nearest height, to the top of hedge or tree or wall; they spin out their little webs as the chasm-crosser spins his. The silk floats out far from the unfed little bodies, and as the wind catches and hauls it into the air the spiders, securely attached to it, rise with it, soar and float away—aeronauts without engines, living balloons.

THE SPIDER-LIKE CREATURES LIVING IN THE OCEAN DEPTHS

That all spiders spin and all have poison is a safe rule; yet there are spider-like creatures in the deep seas, and in the shallow waters near the coast, which, if they are poisonous, certainly do not spin. Silk web would be of no use in such turbulent wastes, it would seem. But are they spiders? The class which we are now considering are technically known as the *Pycnogonida* and are not true spiders. They possess one pair of limbs in excess of the number proper to spiders. The extra pair is devoted, in the male, to carrying the eggs laid by the female.

This class ranges from our own coasts through all seas and all depths. Various species are variously colored. Some are scarlet; some match the corals; some are green in accordance with seaweeds; some transparent; some that live in the deep sea are of a deep purplish red. Some have the gift of swimming; others merely crawl, down in the depths, where the weight of water is such as to crush man-made inventions flat and to reduce vessels of glass to finest powder.

THE LITTLE SILKEN DOOR WHICH KEEPS THE SEA AT BAY

One sea-spider, however, does spin. This is a member of the family of spiders which cover our country hedges with web. The sea species is called *Agalena desis.* It is a master builder of the ocean, making its home in crevices of rocks and coral reefs. At low tide it runs out into the open to feast on small crustacea, and, some say, tiny fish. With the return of the tide it retreats to its home and walls itself up with silk. It shuts out the sea with a doorway of massed gossamer. It can defy the sea whose advances mocked Canute, and when the ocean ebbs afresh it lowers its flimsy portcullis and browses again in its little jungle on the rocks.

Another spider lives in fresh-water pools in Europe. This one is the creator of the diving bell. Something similar, in steel and iron, we used to employ for our submarine engineering. But air and silk are the only materials here. Anchoring itself by a strand of silk to a water plant, the spider marches down the stem and spins a tent of silk beneath the surface.

Then it climbs up, turns the hinder end of its bristly little body into the air and collects a bubble of air in it. Then it dives with the bubble imprisoned between the bristles and its legs, and releases the life-giving supply in its tent. The little home swells, as there is air within it. There the spider sleeps and lays her eggs, rears her babies, and lives the life of an enchanted princess in a fairy cave in the crystal depths.

THE SPLENDID RAFT OF LEAVES BUILT BY A WATER SPIDER

Still keeping to the water, there are spiders which make boats and sail, apparently in search of food, although the "boats" may be rather accidental and the spider may have no definite idea in mind. They weave a silken chain to bind together little leaves into a raft. On this they sail, to plunge every now and then into the water, or rather to walk on it. Water has a film on its surface. Let those who doubt it watch a Raft Spider running over it, secure as a man on ski crossing a snow-field.

Let us turn again, however, to the spinners proper, and pause before our great Garden Spider. Its web is not to be surpassed by any wonder of the tropical spiders. It is made in about an hour. At the beginning of it the spider is a harmless little vagabond; at the end of it she has an estate hung up in the air, a home, a fortress, a snare for the unwary. It is all fabricated from her own small body. Of course she may not rush straight through her task, but may dawdle and dally and then go to work again; but give her one open space, with suitable anchorage, and she can achieve a feat of natural magic.

The first necessity is to fix the beams of her chamber. She may either allow a strand to be blown so that its end may catch a convenient point and form a line; or she may fix an end herself, then drop or crawl down, trailing out silk behind her, till she has reached the point she desires. Here she makes a little dab with the hinder end of the body, and so fixes the thread to where she would have it. She makes, first, two beams roughly parallel, in this way. Then she connects her parallels, and the scaffold of the circular net is there.

THE LINES OF WEB WHICH ARE LIKE THE SPOKES OF A WHEEL

Next, she has to form the radial lines which, all passing through the centre, are like the spokes of a wheel. She builds up the hub as she goes, for we can see her continually adding and strengthening there, putting in new silk and eating up the earlier deposit, or adding fresh material to that already in position.

As she builds she makes her structure her pathway. Having spun one thread, she walks along it to connect the next, and fastens each to the outer beams with a dab of silk. There may be eighteen, twenty or more of these, but they are all quite smooth, not sticky. Then she begins to form the spiral, the great central section of the snare. The building of this is a splendid example of speed, method and prudent care. She walks round and round the skeleton web, across the threads, producing web as she goes, and at each spoke, before attaching the new strand, she gives it a tug with a claw.

The little line stretches, and when it is at its extreme tension she applies it to the spoke, and seems to seal it there with a touch of the spinnerets. Then she is off to the next spoke. The first two or three turns round the growing web simply furnish extra support for the structure, and they, too, are free from stickiness. Now, however, she pours out web which is decidedly sticky, and may remove the smooth spiral.

The sticky substance is pulled out from the spinnerets, and it seems as though the exact amount necessary to reach from one spoke to the next is withdrawn each time, for there is always the same little pull for tightening, always an exact join when she applies the line to a spoke.

THOUSANDS OF GUMMY GLOBULES COVER THE WEB OF A SPIDER

So she goes on, working from the circumference toward the centre, though she may not go all the way around every time. All the spokes are linked up till the web is complete, with hundreds of joinings. Yet it is all one, like so much rubber fabric united when fluid. The work of this great hour is ended. But, you will say, she still has to dot the web with those thousands and tens of thousands of gummy globules. No; she has really finished, and the globules are already forming without special application on her part.

The silk for the snare part of the web issues as a sticky stream. Although it apparently solidifies into silk, the surface does not dry, but retains its stickiness. With the pull of the web this fluid ceases to be an unbroken coating; it parts, as it were, running into little beads, close together, but regularly grouped.

We see, then, that the spider produces different solutions—one for the framework which is not sticky, and one which is like a living gum, fitted to grip and hold any insect which may brush against it. She knows she has these different reservoirs of precious material, and she knows instinctively on which to draw.

The web is one of the most wonderful things in nature. The spider works by instinct, but she adapts her home to varying conditions, throwing out buttresses here to withstand an unexpected strain; adding a stout guy-rope there to pull the web out of the way of a descending drip of water; spinning a backstay where the sway of a shrub threatens to break down the fabric.

HOW THE GARDEN SPIDER MENDS HER BROKEN WEB

It is interesting to watch her when the wind has cast a heavy leaf into the web. She rushes to the breach, cuts the damaged web with her jaws, works till the leaf is free, and drops to the ground. Then she mends the broken web. Into it fly all manner of insects, midges by the score, flies, bluebottles, moths. At the least touch she is alert. She does not see well. She picks up a strand in one of her talons and pulls on it. It is her method of securing directional signals, as our airmen and navigators say. Vibrations travel along her line, and she races up or down the web as though wearing seven-league boots.

If the victim is a fly, she gives it a fatal bite in the neck. She may then settle down to suck it dry, or if she is busy or not hungry, she spins a web all over it, and hangs it there, like a tiny ham on a farm ceiling, waiting till she has appetite.

In the case of a wasp or other stinging creature, she is cautious. She can kill the wasp if she takes it at a disadvantage, but the wasp can kill her in fair fight. So she stands afar off and casts out her web like a little man with a tiny lasso. She nooses the wasp from a distance, runs round and round till she has bound it head and limbs, body and sting. Then she creeps up and makes the fatal wound.

Six spinnerets, fed from about six hundred glands, equip her for her tasks, and one spider has been known to put forth a hundred yards of silk without a pause. There are many other great web-spinners scattered about the earth. The common House Spider is no mean artist, much as tidy housekeepers detest it.

THE LITTLE PARLOR INTO WHICH THE SPIDER INVITED THE FLY

There is a true parlor behind the sheet of web, into which the fly was invited to walk. It has a way in and another way out, to afford escape from danger, and, to crown all, it is weighted with grains of sand or other heavy particles to give it stability. The web of the house spider is a masterly work, but we must give our space to the feats of the trap-door spiders.

These are numerous in species and methods. Some make their traps in

A WONDERFUL HOME MADE OF SILK

The home of a garden spider. It is growing a bit shabby from wind and weather.

The tissue of fine threads at the heart of a spider's silken web.

trees, the majority in the ground. Here is a marvel of instinctive ingenuity. The spider digs a hole in the ground to a depth of several inches, and lines the interior with silk. Then it covers the opening with a lid of silk, but bites this through all the way round, except at one spot. There the silk is left undisturbed and so forms a true hinge to the door.

Next, the spider comes out and with infinite industry collects particles of earth and distributes these over the silken flap; then binds them in place with another layer of silk, adding more layers of earth and silk until the builder thinks it is strong enough. After that the little master craftsman decorates the whole with moss and other tiny pieces of vegetation till it exactly matches its surroundings. One may look directly at the door and not see it. When besieged in this little fortress by an enemy the spider clings to the under-side of the door with its legs and pulls with all its strength to resist the attempt to open the door.

THE HAIRY GIANT AND THE BIRDS IT CATCHES IN ITS SNARE

These Trap-door Spiders belong to the same class as the dreaded bird-eating spiders. They are the giants of the Order—huge hairy brutes six or seven inches across the legs.

They live in trees or in earth-burrows, and weave exceedingly strong webs. In these they are said to catch birds and tiny mammals, such as mice. Their bite is excessively poisonous, and when they have made the fatal bite, they suck the blood of bird or beast as our garden spider sucks the blood of a bluebottle. Their brittle hair also causes intense irritation of the skin.

Another powerful spider is the Tarantula, so named after a spider which, first found near Taranto, in Italy, was supposed to produce dancing mania in its human victim. Tarantism was a common malady of the Middle Ages. Probably it was an epidemic of emotional hysteria, a nervous affection. At any rate, people afflicted believed themselves to have been bitten by the Tarantula spider.

They danced with frenzy until they fell exhausted. Music was supposed to be a relief to their wrought-up feelings, so various melodies sprang into existence for the benefit of sufferers. From them we get the Tarantella of modern music.

THE DEADLY EFFECT OF THE BITE OF THE TARANTULA

How deadly the bite of the spider was we do not know, but it is certain that so-called Tarantula spiders in South America have bitten people and that people have died, but whether from fright, from fear, or actually from the spiders' poison, cannot be determined. Fabre found that bees and wasps die at once from the bite, that a sparrow survives but three days, and that a healthy mole expires thirty-six hours after being bitten.

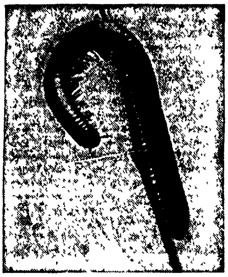
Our common Wolf Spiders are much like Tarantulas. These, though they trail a strand of web after them and make silken retreats in the earth, are active hunters in the open, and stalk their prey like cats, finally leaping on them with unerring accuracy. There are some four thousand species of these spiders, and few are better known than the active jumping species common to sunny walls and sandy banks. Many of these spiders carry their sacks of eggs about with them. The young spiders resemble their parents.

Another interesting member is the Field Spider, which makes a small tubular nest in the crevices of a wall, or in the soil, and runs a labyrinth of strands to surrounding objects, to catch unwary passers-by, as we snare wild animals in a corral. More grotesque are the crab spiders, frequently seen in flowers and interesting because by their sidelong gait they imitate crabs.

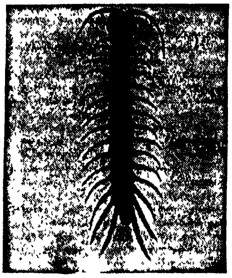
There are a few so-called spiders which are not true spiders at all. There is, for instance, the Harvestman, having a small body with long legs, and being more nearly related to mites and ticks than to the spider. The so-called Red Spider, which bleeds leaves in the conservatory and many precious cultivated crops in the open, is really a mite, but not to be confused with the little red-haired mite whose six-legged larvæ, called harvest mites, attack our flesh and cause itching and discomfort.

Mites are enormously abundant in numbers and species. Many species do not measure more than one-hundredth of an inch, yet they are extremely harmful to ourselves, our animals, birds and vegetation. They all bore and suck juice, whether it be sap or blood. They infest all kinds of life. They cause horrible diseases in man and animals, mange in dogs and horses.

At least eight species of Ticks attach themselves to cattle by their powerful beaks and suck their blood. One transmits the dreaded Texas fever in cattle. For this reason cattle shipped from an infected section are "dipped" in a vat of oil or other fluid to destroy the pest. Some mites infest young chickens or pigeons and hinder their growth. Other parasites commonly found on sheep and which are usually called ticks are not ticks at all, but in reality wingless flies. It would perhaps avoid confusion if they were more generally called by another common name, that of Ked. While the sheep ked has only six legs, the tick, when fully grown, has eight.


A Millipede.

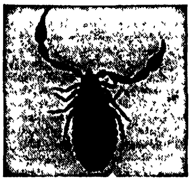
A Scorpion of Central Africa.


A Centipede.

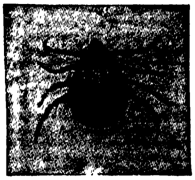
A West Indian Centipede.

Domestic Mite.

Bulb Mites.


False Scorpion.

Currant-bud Mites.


Brown Tick.

There is one tick found in areas where cattle are bred called the Paralysis Tick. In certain parts of Montana this is affected by small parasites which it passes on to man, causing the disease known as Rocky Mountain fever, or spotted fever. In British Columbia we have records of these ticks causing paralysis in men and animals. Paralysis is caused by the female tick when she is feeding fast; if she is sucking blood slowly paralysis does not occur.

The species is found over the greater part of southeastern British Columbia and in the adjacent portion of southern Alberta. It appears as an adult early in the spring and attaches itself to the skin of large wild and domesticated animals and man. After feeding for about seven days the female drops off into the ground and lays about four thousand eggs, which hatch into minute six-legged larval ticks. The larval tick climbs on to grass- or flower-stems, and, when the opportunity offers, gets on to rabbits, squirrels, chipmunks or field-mice. After four days the tick drops off to the ground, molts, and some thirty-eight days later emerges as an eight-legged middle-sized tick. It attaches itself again to the same kind of small animals for about seven days, molts once more, and in about ninety days emerges as an adult tick.

Cattle and horses may carry the tick, but mostly sheep. The commonest tick on horses is the Moose Tick, which, if present in sufficient numbers, will weaken an animal through loss of blood. An arsenical dip is good against it, or greasy preparations which block the breathing pores of the tick, located near its fourth pair of legs. Farmers examining the heavy-wooled parts of a sheep find a number of dead ticks—killed by the lanolin in the wool.

Other mites and ticks penetrate human hair and skin. The skin disease known as the "itch" is caused by a mite. In the South a tiny red mite called the Chigoe, or Chigger, burrows into the skin and causes much discomfort, but is easily killed by salty fat. Ravenous as they are in the presence of food supplies, these mites and ticks can fast perhaps longer than any other known form of life.

To justify in full the title of our present chapter, we have yet to come to the true "many-legs" though all that we have so far considered have more legs than the true insects. Now, however, we come to creatures in which Nature seems to have made a habit, when not otherwise engaged, of adding segments and legs, as if for experiment. The result is seen in the centipedes and the millipedes.

THE POISONOUS LITTLE CREATURES WITH MANY PAIRS OF LEGS

The Centipedes are fierce flesh-eating creatures which lurk beneath stones, bark of trees, or other hiding-places, and stir out only in the dark to hunt and slay. They vary in build, some having but fifteen segments and as many pairs of legs; some having about a hundred. The number of paired legs is always an odd one. In the centipede, for example, the number of pairs would be 99 or 101, never 98 or 100.

The tropical centipede can paralyze a rabbit instantly by a touch of its poison. The thought is unpleasant, but so are most of the things with which the centipede grapples—for our good. The same Hand which gave the rose its thorn, the nettle its sting, the cactus its appalling defenses, the snake and devilfish their venom, decreed this lethal fluid for the centipede, and enabled him to administer an anæsthetic to his victim.

THE MILLIPEDE THAT EATS UP THE ROOTS OF THE CROPS

The Millipede is innocent of poison. Long-bodied and oval, he has more legs than most of us would count. His feeble, filament-like limbs are admirably adapted for the millipede's wriggles through the earth, where he gnaws the roots of our crops. His purpose in the scheme of the world's economy seems to be to destroy rubbish and decaying vegetation. If we plant our vegetation in land which has been his family's from ancient time, then we invite him to appease his appetite.

It is curious that the poisonous centipede and the harmless millipede should arise from the same stock, but they are said to have done so. Some of them can twist and turn with an activity which would do credit to an eel, but others, smaller and less powerful, have borrowed the habit of the trilobite, and, like the wood-louse and the hedgehog, can coil up into the semblance of a pill.

Creepy, crawly things are the subjects of this chapter. They were greatly dreaded by the people who came before us. They inherited their fears and the notions on which they were based. The ancients exalted the crab and the scorpion to the dignity of the stars, and there, in the zodiac, they are to-day. Can we wonder that men and women who firmly believed that their lives were governed by special stars should look with fear on creatures whose form they thought they espied and named up in the gleaming heavens?

We preserve the zodiac with its portrait gallery, but no longer are we afraid of the creatures in it. In that we are more enlightened than our ancestors. We know more of the nature of the creatures themselves than Shakespeare and Bacon knew. For that reason we have still a wholesome dread of scorpion and poisonous spider, but the dread is a rational one. It does not make us fear that a scorpion will suddenly take wing and breathe down fire on us, or that a spider will turn from the devouring of snakes to devour us.

A spider, said our old wise men, is a worm of the air; and that, in the language of that day, meant a snake. Spiders are everywhere, but, after all, we know that every spider in the world is the potential enemy of some insect that might injure man's purse or person, although most of its victims could not harm us and might even help us. As for the mites and the ticks, we can think of no benefit that we derive from them, though perhaps a few species do feed upon scale insects which attack our crops.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 6063.

Why Does the Wind Blow?

THE wind blows for the same reason that smoke comes out of a chimney. This is a curious answer, but it is correct. The real cause of the wind is that air expands and rises as it becomes warmer. If we take an empty bottle, stop its mouth not too tightly with a cork, and place it in front of a fire, the cork will pop up. The air inside the bottle as it gets hotter from the fire has expanded and pushed out the cork. By this experiment we can prove that, even in a small space, air moves if the temperature changes.

Heat rays that have traveled to us from the sun bounce back from the earth and warm the air. Some parts of the earth radiate this heat more readily than others; therefore in some places the air is warmer than in others. The warmed air, being lighter than cold air, rises; the cold air, being heavier than warm air, rushes in to fill up the place which the warmer air occupied before it began to rise. That is the reason why the wind blows, given as simply as it can be given.

Generally, a breeze from the sea begins to blow on to the land a few hours after the sun has risen. Again let us ask—why? Land warms up faster than water under the heat of the sun, so the air over the land rises, and the cooler air from the sea blows in to take its place, only to be warmed in its turn, and to allow more cool air to blow in from the sea. When the sun has set, the land becomes cool more quickly than the sea, so that the air above the land is denser, or heavier, than the air above the sea, and the cooler land air blows out to sea to replace the sea air that is rising because it is warmer.

WHY ARE SOME WINDS WARM AND SOME COLD?

Winds become like the surface of the earth over which they travel. A wind that blows over a hot, dry desert becomes hot and dry; a wind that blows over ice-fields and snow-clad mountain tops becomes piercingly cold; a wind that comes from tropic seas is likely to bring warm rain. The mistral of southern Europe is a famous dry, cold wind that blows from the Alps, in winter and early spring. The sirocco is a famous wind that blows northward, hot and dry, from over the African desert part of the year, and blows in the other direction, moist and warm, from over the Mediterranean Sea, another season.

WHAT IS A WHIRLWIND?

A whirlwind is caused by winds coming from opposite directions at the same time. When such winds meet they make a circular motion with great violence, and, being pressed on by more wind coming behind, may be driven upward with such force that at sea they may lift a column of water with them, thereby making a water-spout. Tornado and cyclone are other names for the same kind of disturbance as a whirlwind.

WHAT IS A HURRICANE?

This word comes from a Carib Indian name for a very violent windstorm in the West Indies, usually blowing up in the autumn. The word is now used to denote such a wind, sometimes accompanied by thunder, lightning and rain in other parts of the world, chiefly in tropical regions. In the China Sea and the East Indies these storms are more often called typhoons.

Before the days of steamships sailors used to look forward with dread to the autumnal gales. Often they would battle with the elements for days together. The sails would be torn to shreds by the fury of the wind. The mighty, foaming seas would charge upon the ship like an invading host beating with terrific force upon the decks, sometimes carrying away the masts. The gales are not such a danger to shipping as they once were, for nowadays steamships are given warning by radio of approaching hurricanes, usually in time to get out of the way of the great winds.

WHAT DO WE MEAN BY THE TRADE WINDS?

The trade winds are the most regular winds in the world. The trade wind in the Northern Hemisphere blows steadily from the northeast, and the trade wind in the Southern Hemisphere blows steadily from the southeast; and both vary so little that in the old days sailing ships could rely on them with absolute confidence. These winds create a delightful, cooling breeze on such islands in the tropics as the Virgin and Hawaiian islands.

The forces behind the trade winds are two—the heat of the sun and the rotation of the earth on its axis. The heat of the sun in the tropics causes the air in these regions to rise, and cold air from the Poles rushes in to take its place. These cold currents, rushing south from the North Pole and north from the South Pole, are the foundations, so to speak, of the trade winds. But, if that were all, the trade wind in the Northern Hemisphere would be a north wind instead of northeast, and the trade wind in the Southern Hemisphere would be a south wind instead of a southeast. What is it that gives the trade winds their westerly direction?

It is the rotation of the earth. As the winds rush north from the South Pole, and south from the North Pole, the earth is rotating from west to east through the winds, and so the winds seem to blow from the northeast and southeast. If a man travels fast eastward in a motor car while a wind is blowing from the south, the wind will seem to be southeast; and if the wind is blowing from the north it will seem to be northeast. In the same way, as we rush eastward on the rotating earth, the north and south winds from the Poles seem to be northeast and southeast winds.

WHAT MAKES THE WIND WHISTLE?

The howling and whistling and all the other noises made by the wind are not so easily noticed by us when we are out-of-doors as when we are in a house. As the moving air forces itself through chinks of doors and windows, or perhaps even down the chimney and so on, it sets all sorts of things that it meets vibrating, or trembling, and so produces all kinds of sounds, and these are often almost musical. At night they can seem very weird indeed. Outdoors the wind passing through the air—that is to say, the current of air passing through the air—may set the leaves of a tree to whispering, as we say, if the wind is gentle. A strong wind may cause the branches to vibrate in a way that sometimes sounds like moaning. In every case it is not the wind itself that we hear but vibrations caused by the moving wind.

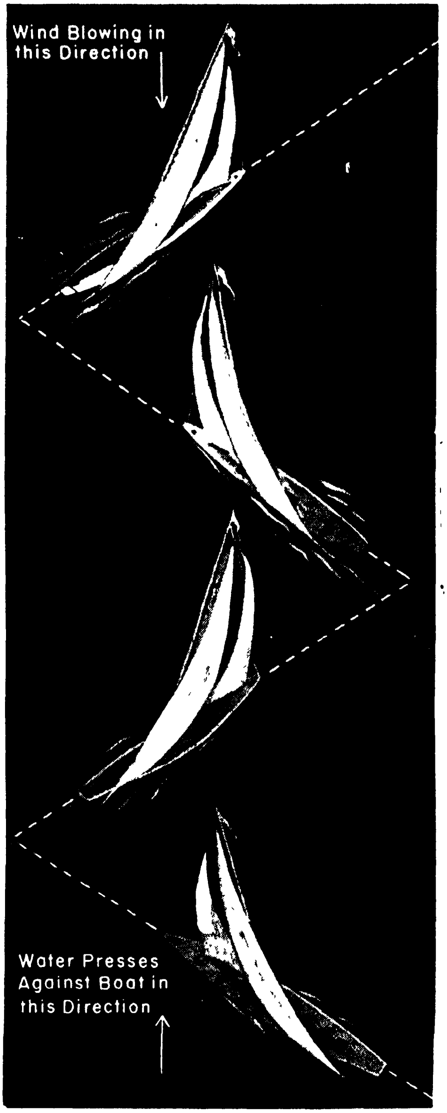
HOW DO SHIPS SAIL AGAINST THE WIND?

There are many ways in which man uses the wind for his purposes. He erects a windmill with sails, and the wind drives these round and round, working a machine that will grind corn or pump water or run a motor to generate electricity. Man also uses wind for drying his clothes after they have been washed.

But the chief use to which he puts the wind is transport. This was, no doubt, one of the very first ways in which he made use of the wind. For thousands of years vessels have been driven by the wind. The wind was, indeed, one of the first natural forces man ever used; and he soon learned how to sail a boat in any direction he pleased, not merely in the direction of the wind.

A sailor changes the position of the rudder of his boat and catches the wind in such a way that he can use it to drive his vessel even in the opposite direction from that in which the wind is blowing. This is done by taking a zigzag course known as tacking. It consists of turning the ship a few points to starboard, then a few points to port, then to starboard again, back to port, and so on, much as you might direct a course through a crowd of people, darting first right, then left, taking advantage of every small opening but always making some small headway forward.

The diagram on this page will help us to understand how tacking is performed. When he wants to drive his boat in the teeth of the wind, the sailor turns his rudder and sails a zigzag course. The boat is turned by means of the rudder, so that its side is presented to the oncoming wind. This would drive the boat before the wind, but the resistance of the water on the opposite side prevents this. The vessel, therefore, takes the line of least resistance—that is, it follows the easiest path and goes in a slanting direction, as indicated by the dotted line in the diagram. When the rudder is turned and the boat changes its direction, the sail is swung round by the wind. In the diagram we are looking down on the boat, and the long line shows the position of the sail and the short line at the stern the position of the rudder.


Wind Blowing in this Direction
Water Presses Against Boat in this Direction

How a sailboat can be made to go against the wind by taking a zigzag course.

After going for some distance in this direction the rudder is changed, and the boat turns round, catches the wind, and takes a slanting course in the other direction. By doing this repeatedly, and tacking from side to side, the boat eventually reaches its haven. To learn to tack, or to beat up to windward, as it is called, is one of the most important things a sailor has to learn.

WHAT IS A TORNADO?

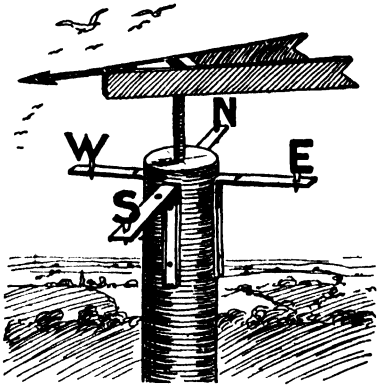
The word tornado means turning, and from this we may readily see that it is a kind of whirlwind. It is caused by the air becoming so hot that it rises with great rapidity. This causes a sort of vacuum. The air all round rushes in to fill the vacuum. As the air is carried up it becomes cooler, expands and forms a cloud, which spreads itself outward in the sky so that the tornado looks like a huge funnel hanging from a heavy black cloud. The motion of the currents usually commences close to the ground, but a tornado may be carried along some distance up in the air. The speed with which it moves is so great that it sweeps everything before it; but happily it takes a much narrower path than a whirlwind does, and as a rule it does not last long.

A tornado or a whirlwind over the ocean is called a water-spout.

THE NEXT WONDER QUESTIONS ARE ON PAGE 6173.

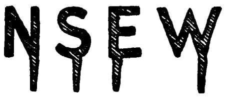
AN EASILY MADE WEATHER VANE

ANY boy or girl can set up a weather vane with little trouble and at very little expense. The weather vane that we describe may be set up in any open space.

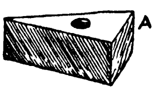


1. The weather vane in position.

First we obtain a fairly stout pole or post; it should be straight, but it does not matter whether it is round or square in shape. Near the top of the post we screw, at right angles to each other, four iron right angles, such as may be bought for a few cents. Figure 1 shows how the four right angles are to be fitted; upon them are to be placed letters indicating the points of the compass. To be sure that the angles are correctly set in position it would be well to draw a straight line through the center of the top of the post, then to draw another line through the center, at right angles to the first. The use of a T-square would enable you to obtain a perfect right angle. The four iron angles could then be set in position directly under the lines.



2. The letters.



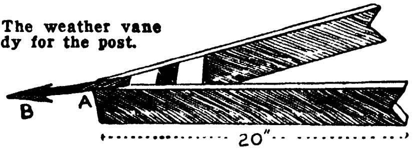
3. The wedge.

With a jigsaw or fretsaw or with chisel and hammer we now cut out four wooden letters, N, S, E and W, with an arm underneath each as shown in figure 2. In each case the arm should be inserted in a screw hole that you will find on the top part of the iron angles that you have just fitted to the post. N should be opposite S, E opposite W; the order of the letters, clockwise, should be, N, E, S and W. The arm of each letter should be wide enough to fit snugly in the hole of the right angle. It can be kept perfectly firm in the hole by inserting a small piece of wood on each side of it.

Next, we make a hole in the top of the post and firmly insert an iron rod about ¼ inch in diameter, so that it protrudes 6 inches above the post. The pole is now ready; it should be set up at a spot that is open to the winds from all directions. A sheltered spot would be quite useless. In erecting the post, we should dig a hole about two feet deep, insert the post and then fill in the earth, pressing it down very tightly. In setting up the post, we should be sure, of course, that the N, S, E and W point actually to these different points of the compass. A pocket-compass may be used as a guide.

Now we make the weather vane itself. We take a wedge-shaped piece of wood as shown in figure 3, and bore a hole right through it. The diameter of this hole should be large enough so that it will turn quite easily and smoothly on the iron rod at the top of the post. Then we nail across this hole at the top of the wedge a piece of sheet-iron, so that the rod will not go right through when the wedge is slipped on the iron rod at the top of the post.

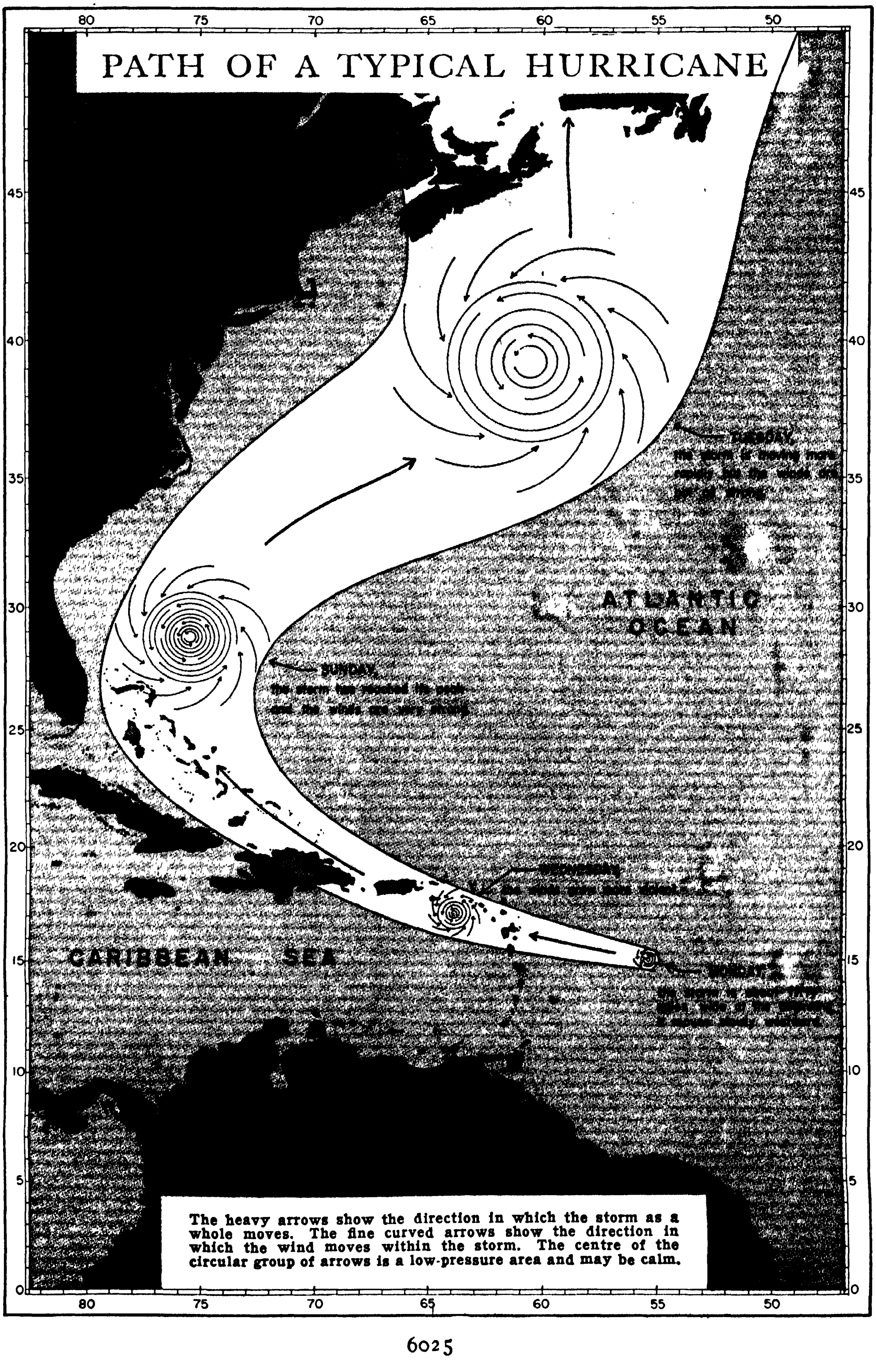
4. The weather vane ready for the post.



On each side of the wedge we screw a piece of ¼-inch board, 4 inches wide by 20 inches long (see figure 4). A metal or wooden arrow is then cut or sawed out and screwed on to the vane to act as the pointer B, as illustrated in figure 4.

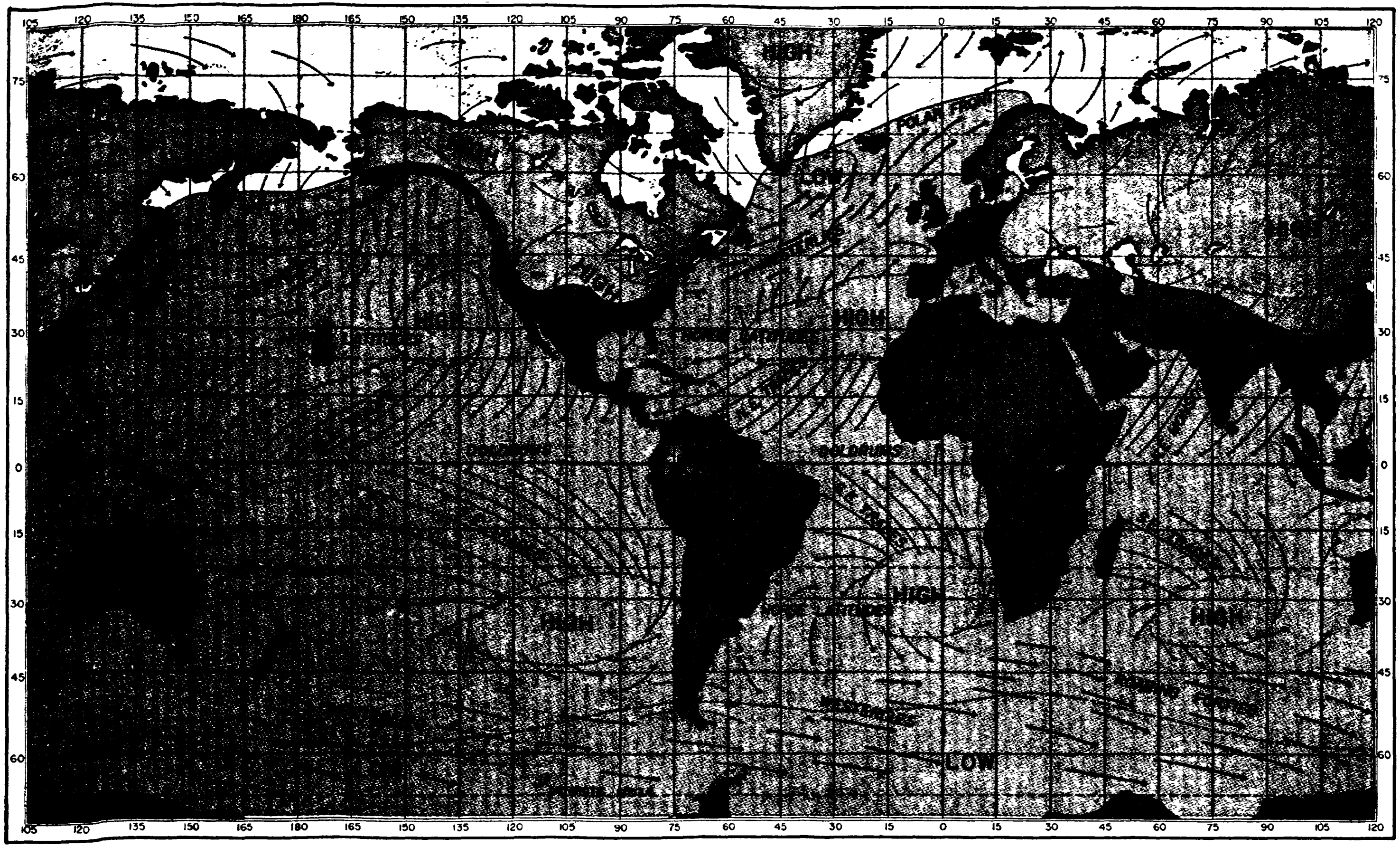
We now lift the vane on to the rod at the top of the post. We fit the rod into the hole in the wedge; and then our weather vane is ready for use.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 6141.


PATH OF A TYPICAL HURRICANE

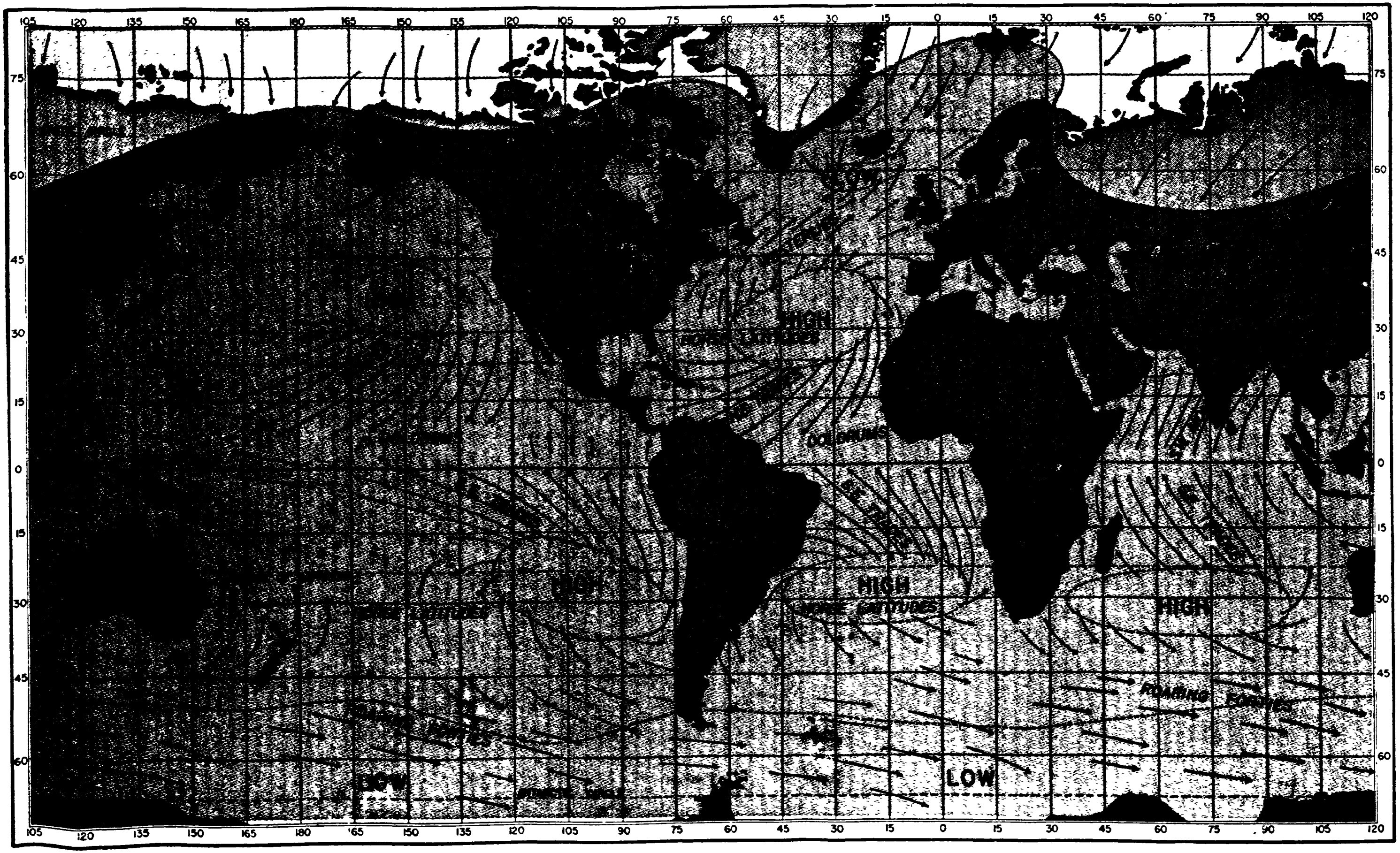
The heavy arrows show the direction in which the storm as a whole moves. The fine curved arrows show the direction in which the wind moves within the storm. The centre of the circular group of arrows is a low-pressure area and may be calm.

JANUARY PRESSURE AND WINDS



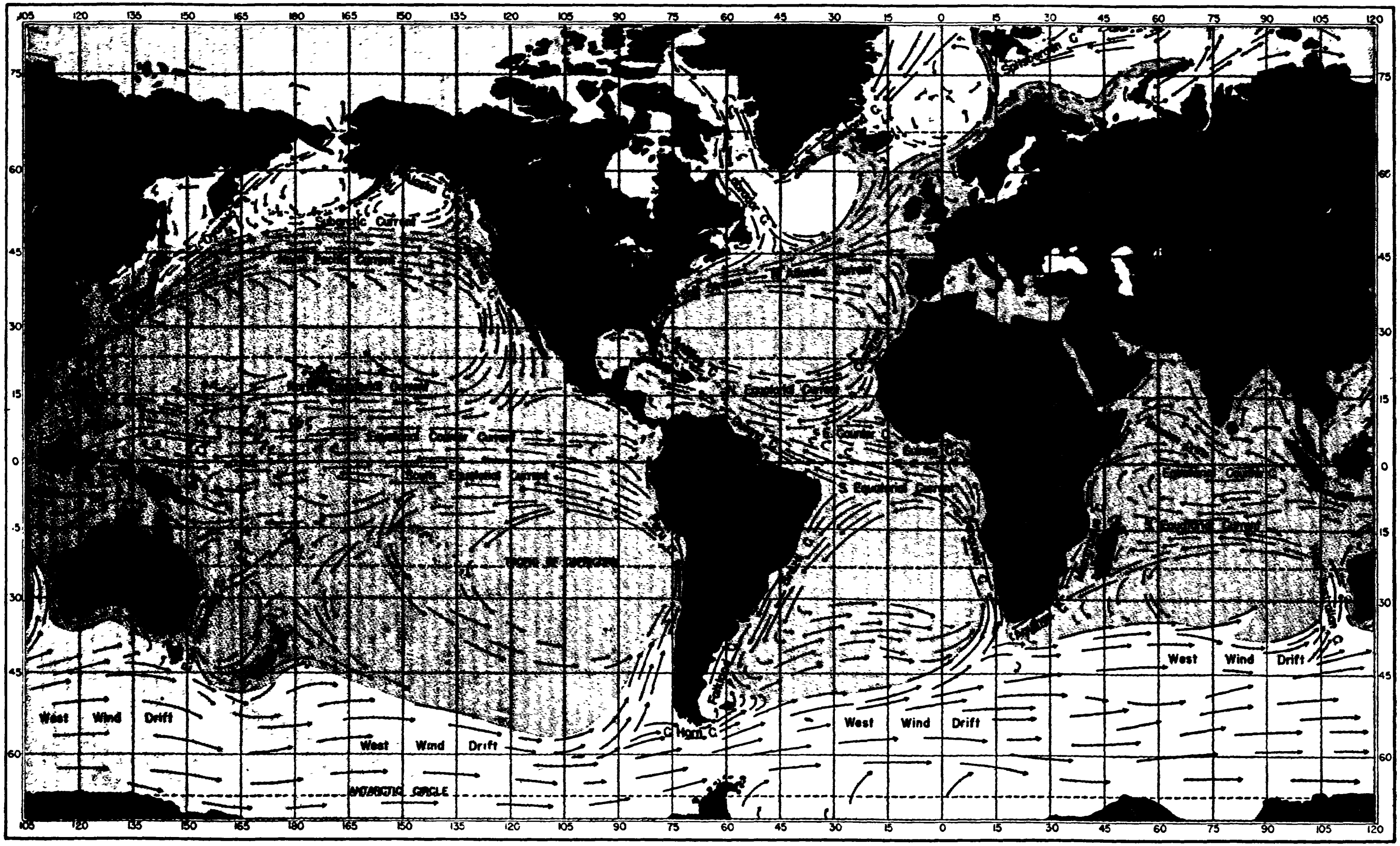
Low- and high-pressure areas, and prevailing winds in January. The Polar Front line shows the average southern limit of the cold North Polar Maritime and Polar Continental air masses. In North America this extends to about 35 degrees north latitude. In July (see the chart on the next page) the line does not dip below the Arctic Circle in North America. Near the Equator are areas of calm, or of feeble winds, known as the Doldrums, from an old word meaning dull.

JULY PRESSURE AND WINDS



Heavy arrows indicate strong winds, for instance, the Roaring Forties, south of the Equator. Notice how the dry Monsoons (Asia) blow from the land in January, and the wet Monsoons from the sea in July. In the Horse Latitudes, calms prevail. Sailing ships carrying horses from New England to the West Indies were sometimes becalmed on the way. If fresh water ran short, some of the horses were thrown overboard and so the Horse Latitudes got their names.

THE OCEAN CURRENTS



This map shows the ocean currents. The parts of oceans that are light-colored in this map have cold water; they are, as you see, in bands north and south of the warm waters (dark-colored). Trace the Gulf Stream, the Labrador Current, also the Peru and Falkland currents which move up the coasts of South America. The double arrows ⟷ show the Monsoon drifts near Asia which reverse their direction in summer and winter. See the wind charts on pages 6026 and 6027.

WINDS AND OCEAN CURRENTS

THE WINDS

METEOROLOGY is the science of wind and weather. For centuries man has wondered where the wind comes from, and where it goes. Certain things about the wind were easily observed; for instance, it was known that in some localities it would blow from the southwest most of the time during the warm months of the summer, and that when the cold winter came it would just as surely blow from the northwest. But even in such places it was uncertain; the wind in midsummer might, on any day, come from any direction, or there might be no wind at all.

Men looked at the sky, at the clouds, and at the sun and moon for signs of what weather to expect. If they saw a certain cloud formation before the coming of a strong northwest wind, then naturally they associated that cloud form with that wind. To farmers, to seamen, to travelers, to people in all walks of life, a knowledge of what the winds are going to do has been, and is ever, of great importance. Will the wind that blows tomorrow be cold or warm? Will it bring rain or snow or sleet? Will it blow so hard that it damages crops and buildings? Before answering any of these questions, before making any attempt at forecasting the weather, man had to answer one question: "What causes the winds to blow?"

Before talking about the causes of the winds let us make sure that we understand all the words used in the explanation. We can cover only a tiny part of the study of winds, which is part of the science of meteorology, but even so we must be scientists enough to use our words accurately. To begin with, what is wind? It is simply air in motion; and air is a mixture of gases and water vapor, with very, very small drops of water and dust floating about in it.

Keystone View

The tornado "twister" over the ocean is called a water-spout.

Though the air actually moves in all directions, upward and downward as well as horizontally, it is only the horizontal motion which we commonly call wind. It is still wind, strictly speaking, when it goes up or down, but these motions are called up-drafts and down-drafts. The direction horizontally is always expressed as *the direction from which the wind blows*. Usually the compass points are used. For instance, a northwest wind is air coming from the northwest toward the southeast; a south wind is one coming from the south and blowing toward the north. When we wish to show a wind's direction on a chart, we draw an arrow which points in the direction in which the wind is going.

The motion of the air is measured in many different ways, such as feet per second, or miles per hour as we measure the speed of a car, or in knots as we measure the speed of ships, or with the Beaufort scale which is numbered 0 (representing calm) up to 12 (representing a hurricane). It is difficult to measure the exact speed of the wind, since the air usually does not move steadily, and the speed varies a great deal, depending on how high off the ground it is measured.

The primary cause of the wind is the heat which the earth receives from the sun. This heat, strangely enough, does not warm the air very much as it passes through on the way to the ground. The air receives most of its warmth from the heat that radiates back from the earth's surface. Some parts of the earth's surface radiate heat more readily than others. The land radiates more heat to the air than does the water. Also, as the earth revolves about its axis and moves in its orbit around the sun, it receives more or less heat on various areas of its surface according to its position. When it is cold in the Northern Hemisphere, it is warm in the Southern. When it is day on one side of the world, it is night on the other.

So, since the area heated is constantly changing, winter and summer, day by day, the difference in temperature between one place and another is also changing. As we shall explain, the changes in temperature cause the wind to shift its direction and its speed. However, in spite of their seemingly erratic behavior, the winds, on the average, do follow set patterns.

When air is heated, it expands. This means that the same amount of air takes up much more room when it is warm than when it is cold. Therefore any given amount (a square foot, for example) of warm air weighs less, that is, exerts less pressure on its surroundings, than the same amount of cold air. This low-pressure air rises to the upper atmosphere and there spreads out. This increases the pressure in the surrounding areas. When the pressure is high, the air sinks and spreads out across the surface of the earth. It is this last movement of air across the earth's surface that we know as the winds.

Moist air is lighter than dry air, so we call an area that contains warm, moist air a *low pressure* area, and one that contains cold, dry air a ***high pressure*** area. To measure this pressure of the air, the meteorologist uses an instrument called the barometer. We generally refer to these pressure areas as simply *High* or *Low.*

If you look at the Wind and Pressure charts of the world, pages 6026 and 6027, you will see that the wind-direction arrows point out of the high-pressure areas and into the low-pressure areas.

"But," you will say, "why do the arrows curve? None of them goes straight from a High to a Low." You are right. The reason for this is the movement of the earth about its axis. As the air moves from a high-pressure area to a low-pressure area it is forced to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This curving of the wind as it goes into a low-pressure area is known as a cyclone, or a cyclonic wind. The wind is a strong one if the drop in pressure is great. The movement of air out from a High is called an anti-cyclone. You can see that in the Northern Hemisphere a cyclonic wind moves in a counter-clockwise direction, and clockwise in the Southern Hemisphere. (Clockwise means the way the hands move on a clock; counter-clockwise, of course, means the other way round.)

The word cyclone has two meanings. It is the name given to certain tropical storms; but for the meteorologist it describes the movement of air into a low-pressure area, and it may be a violent storm or it may not. Sometimes a low-pressure area is quite large, more than a thousand miles across, in which case the winds may not be very strong.

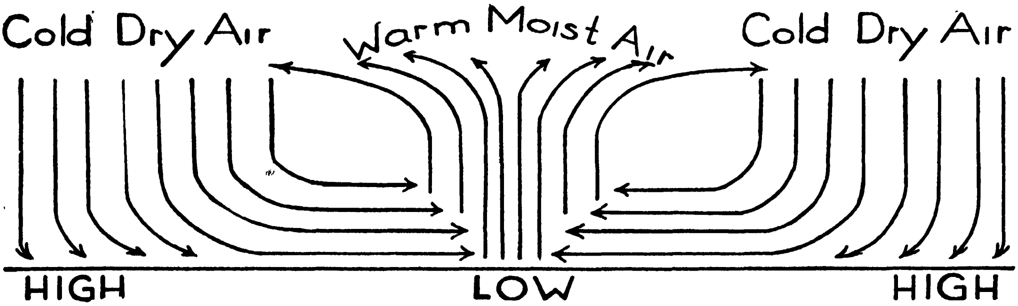


Figure 1. How the air moves from a high- to a low-pressure area. Warm, moist air rises and spreads out. Cold air (which is heavier) sinks and spreads out below. The diagram is very much exaggerated.

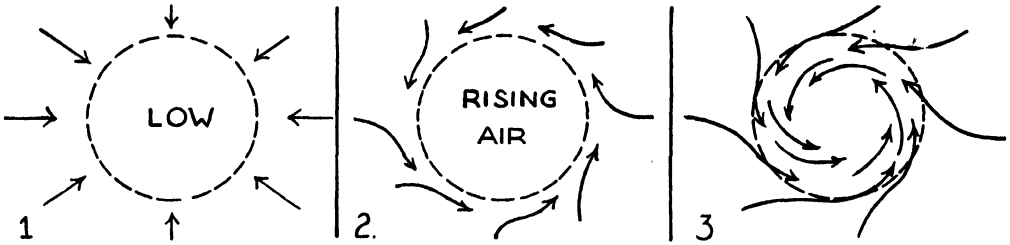


Figure 2. Wind in the Northern Hemisphere. 1) Arrows point out of high-pressure into low-pressure areas. 2) The earth's rotation causes winds to curve (a cyclone). 3) Counter-clockwise cyclonic motion in Northern Hemisphere.

If the earth's surface were all one material (if it were covered with water, for instance) then the wind systems would be comparatively simple. Around the world at the Equator there would be a belt of low pressure, since that area receives so much direct heat from the sun. Both north and south of this belt there would be belts of high pressure because the warm, rising air of the Equator would spill over, increasing the pressure on either side. Next, in the subarctic and subantarctic there would be belts of low pressure, with strong winds. And last there would be high-pressure areas, due to the cold, at the two Poles. The winds would then blow in the directions shown in Figure 3. The belts of low and high pressure would move north and south with the seasons, north during the Northern Hemisphere's summer, and south during the northern winter.

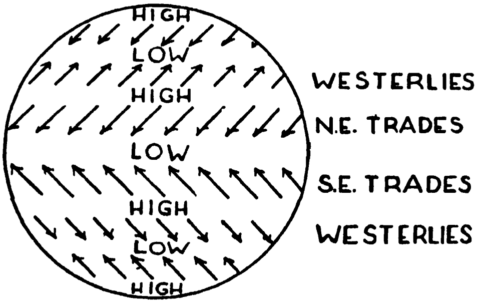


Figure 3. The regular pressure belts we would have if the earth were entirely covered by water.

As a matter of fact, since by far the greater part of the surface of the earth is covered by water, the wind systems are something like those on our imaginary water-covered globe. The northeast and southeast trades do blow consistently toward the Equator; we do have a region of prevailing westerly winds. But the only one of these wind belts that extends completely without interruption around the world is the belt of the westerlies in the Southern Hemisphere, because in this region the surface of the earth is entirely covered with water, except for the tip of South America.

During the summer months air masses that lie over the land are much warmer than those over the water. (We have already said that the land radiates heat from its surface much more readily than the water. The sea absorbs much of the heat, and gives it back slowly.) In winter, therefore, the air over the sea is warmer than that over the land. This is especially true where the land area is large. So we have a relatively low-pressure area over the land in summer and a High in winter. Consequently the winds blow onto the continent in summer and away from it in winter. These winds are known as the monsoons. The best known monsoon is the one that blows across the Indian Ocean onto the continent of Asia. As with the word cyclone, monsoon is often thought of as meaning a violent storm, but that is not the case. The northeast monsoon that blows in winter across southern Asia, out over the Indian Ocean, does not bring any rain and the winds are quite moderate.

This seasonal changing of temperature and pressure over the continents of course plays havoc with our simple diagram of high and low pressure belts as shown in Figure 3. We now see that there can not be any continuous belts of high and low pressure around the world where the belts pass over both the continents and the oceans. Because of this, the pressure areas and their resultant winds break up into the patterns as you see them on the Wind and Pressure charts. Over the oceans the winds blow in much the same directions in winter and summer. It is only near the land that the large changes take place with the seasons

There are two important things to remember when we study average wind charts. First, because of the small size of the charts, many winds that are very important locally are not shown. Every mountain, every river has its own effect on the prevailing winds. A chart may show southwest winds as the summer condition in a certain large area; yet because of the lay of the land there may be a valley in that area where the summer winds are southeasterly. The second thing to remember is that these charts show average conditions. That is, the winds usually blow in these directions, but not always, especially not on the land areas. The trade winds, which are over the oceans, can be expected to blow as indicated on the chart, though they may be a little stronger one day than the next. The westerlies in the southern Atlantic are almost as certain and can be relied on to blow at gale force a good deal of the time during the winter.

Let us now consider the storms, or disturbances, as the meteorologist refers to them. A storm is a small, traveling, low-pressure area. When it starts it moves very slowly, gradually increasing its speed and size until it may be as large as eight hundred miles in diameter. When a disturbance has reached such proportions, the winds are not nearly so strong as when the storm area was smaller. The strongest winds are associated with the smallest and briefest disturbances. For example, there is the tornado of the United States which may last only a half hour, and measure only one thousand feet across, but which does considerable damage even in that short time. The change in pressure is very great in these storms, and the air rises very rapidly.

The polar front, as shown on the Wind and Pressure charts, indicates where the cold air from one of the Poles meets the warmer tropical air. It is a constantly shifting front, and it is along this boundary line that most depressions travel. The front does not always represent a sharp change in temperature, but wherever there is an abrupt change, that is where a storm is most likely to be severe. The polar front line on the Wind and Pressure charts shows how the cold air moves down over the continents during the northern winter, and recedes in the summer.

On the Wind and Pressure charts you will find the names given to the major wind systems, such as the trades and westerlies. You also will find the names given to those areas where there is rarely any wind at all, the doldrums; and where the winds are light and variable, the horse latitudes. Not shown or named are the northers that blow across the Gulf of Mexico in the winter; the tornadoes that usually occur in the upper Mississippi and Missouri valleys of the United States; and the Santa Ana in California, a hot wind that blows from the desert toward the Pacific Ocean. There are hundreds of other winds all over the world, many of them having very strange names, such as the "elephanta" of India, the "williwaws" in the Straits of Magellan, and the "southerly buster" in Australia.

The names that are most familiar to us are those given to the storms. The hurricane is a tropical storm that occurs in the western parts of the oceans near the Equator, that is, in all the great oceans except the South Atlantic. Though we call this storm in the West Indies a hurricane, the ones in the Indian Ocean are called cyclones, those in the China Sea are called typhoons, and the Australians, who like unusual names, call the tropical storm that occurs off their northwest coast the willy-willies.

Almost 150 years ago, a British admiral, Sir Francis Beaufort, devised a method of guessing the wind's velocity. This instrument is still used on ships, though it is not very exact. The Beaufort scale, as it is called, registers winds as shown below:

THE BEAUFORT SCALE

Scale Number	*Speed of Wind in Statute Miles*	*Description of Wind*	*Indications on Land*
0	Less than 1	Calm	Smoke goes straight up
1	1 to 3	Light Air	Smoke drifts
2	4 to 7	Slight Breeze	Leaves rustle
3	8 to 12	Gentle Breeze	Leaves and small twigs are in motion
4	13 to 18	Moderate Breeze	Dust flies, and paper; small branches move
5	19 to 24	Fresh Breeze	Small trees sway; wavelets on water
6	25 to 31	Strong Breeze	Large branches move; umbrellas are blown
7	32 to 38	High Wind	Whole trees move; walking is difficult
8	39 to 46	Gale	Twigs break off
9	47 to 54	Strong Gale	Loose shingles and chimneys go
10	55 to 63	Whole Gale	Trees may be uprooted
11	64 to 75	Storm	Damage is widespread
12	Over 75	Hurricane	Anything may go

THE OCEAN CURRENTS

No one knows who the first ocean travelers were. But whoever they may have been, no doubt one of the first things they noticed, apart from the huge quantities of water, was that the water beneath them would often carry their boats from place to place, even when there was no wind to blow them about. Certainly the tides, the rising and falling of the water along the coasts, must have been known to man thousands of years ago. And he soon found, if he lived on a small bay or inlet, that when the tide was coming in he had a difficult time putting out to sea in his tiny boat. So it was that he first learned of ocean currents. But it was many more centuries before he realized that there are other and much larger currents in the oceans than those caused by the rising and falling tides.

Tidal currents, especially where they flow between land banks, move much more rapidly than do any other of the ocean currents. But tidal currents are nowhere near so large and do not travel so far as ocean currents. The speed of ocean currents can not be compared to air speeds. The fastest tidal currents rarely move more than 6 miles an hour. This, compared to known wind speeds of 150 miles an hour, is very slow indeed. Yet for ships at sea even a current with a speed of one knot means something. The most interesting things about ocean currents, however, are the direction in which they travel, and the amount of water that they transport.

The direction in which a current is moving is called the set of the current. A northeasterly current is one setting, or moving, toward the northeast. The speed of the moving water is expressed in knots, and is called the drift of the current. A knot is equal to one nautical mile per hour (about 2,029 yards).

There are three main causes of the ocean currents, giving rise to three different types of water movement. The first is the attraction of the sun and moon, which causes the tidal currents. The second is the prevailing winds, such as the trades and westerlies, which through friction set the water in motion. The third cause is the heat from the sun which affects the density of the water. The differences in density from one place to another cause the water to move, much as the differences in air pressure cause the winds. Warm water is lighter, less dense, than cold water. The density of sea water is affected not only by the temperature, but also by the amount of dissolved salts it contains. The more saline (salty) the water, the heavier it becomes.

If you will look at the chart of the ocean currents, you will see the names of all the major currents, the arrows showing the directions in which they flow. You will notice that most of the names given to the currents are simply the names of the countries by which they pass, as the Brazil Current, the California Current. One of the notable exceptions to this custom is the Gulf Stream. Its name brings up an interesting point.

It was named the Gulf Stream because it was supposed to come from the Gulf of Mexico, but observation has shown that it has three major sources—first, those waters from the Caribbean Sea which follow the shores of the Gulf; second, those Caribbean waters which flow directly by the north coast of Cuba; and third, the Antilles Current which forms part of the Gulf Stream north of the Bahama Islands.

We can not point to the beginning of any of the major ocean currents. The names we give them are simply for convenience in locating and pointing out the changing characteristics of the current patterns in the oceans. So the system of naming currents according to where they are, or by the names of the countries which they pass, is a simple and convenient one.

All the major ocean currents carry vast amounts of water over long distances. Since water temperatures change slowly, currents act as cooling or warming agents upon the land masses near which they flow, depending on whether the currents come from cold or warm regions. We call a current warm if its surface waters are warmer than the water through which it flows. Actually, if it is a deep stream, a "warm" current may be carrying along extremely cold water well beneath the surface. Except for the tidal currents along the coasts, very rarely does an ocean current reach to the bottom. If the current is caused entirely by the wind, it will be comparatively shallow. The deepest currents are those caused by changes in density of the water.

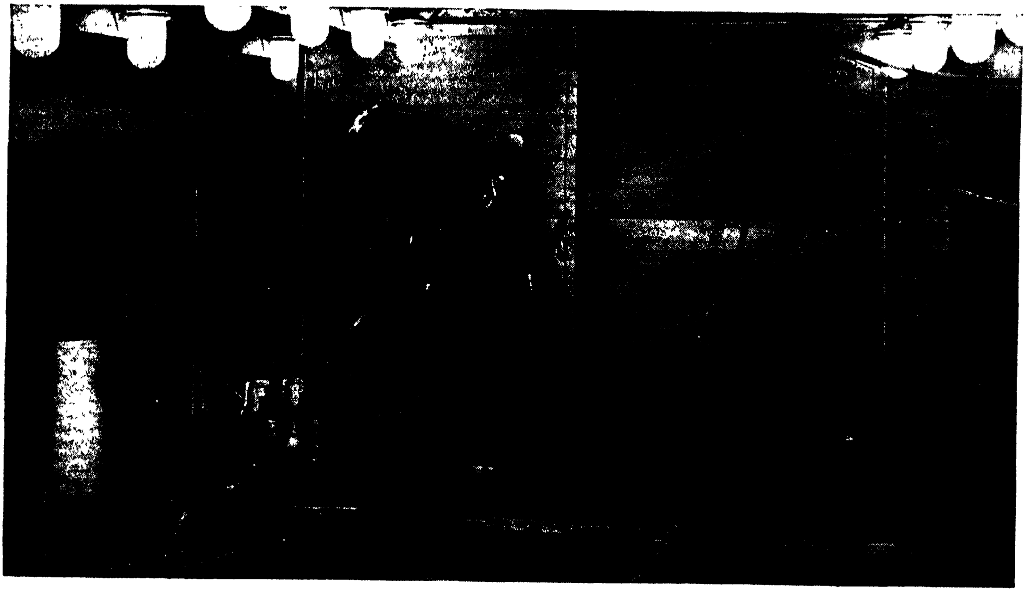
The inshore tidal currents reverse their courses every six hours or every twelve hours, depending on the tidal period. The offshore tidal currents constantly change their direction of flow, and are often called rotary currents. The currents called monsoon drifts, caused by the monsoon winds, change their course with the seasons.

By FREDERICK FUGLISTER.

THE NEXT STORY OF THE EARTH IS ON PAGE 6199.

Courtesy, Hawthorne Works, Western Electric Company

Workers at an electrical manufacturing plant, receiving instruction in safety measures. Carelessness at work, leading to accidents, is an aid to the enemy in the battle of production. Many schools nowadays have projects in safety education; and insurance companies wage safety campaigns showing that most accidents can be prevented.



Courtesy, Sly Manufacturing Co.

This man is not a deep-sea diver, as you might at first glance suppose. He is a sand-blast worker, and the suit gives him protection from the fine, cutting sand. The airtight helmet is fitted with a pipe through which he receives oxygen for breathing. The oxygen pipe is at the right.

SAFETY IN INDUSTRY

Courtesy, Industrial Gloves Co.

Goggles and gloves protect this worker from sparks.

ANY boy or girl who is on the safety patrol at school knows how important safety rules and precautions are. The safety patrol officer is always on guard against accident. Safety in industry means keeping the worker safe, as he does his job, by protection of various kinds against accident, by providing healthy working conditions and by setting up safety rules. In industry, in plants that produce steel, tanks, guns, chemicals, glass, electrical goods and all our manufactured articles, safety is an even greater problem than in school because the men must use powerful machinery and handle materials which could be dangerous to life and limb.

Safety in industry is important in helping to win the war. When Napoleon was fighting his battles, one worker could produce all the equipment necessary to keep two soldiers supplied on the battlefield (equipment means arms and ammunition—tanks, guns, fighting planes, too—as well as clothing); at the time of the Franco-Prussian War, in 1870, one worker was needed for every soldier; in World War I five workers in the factories were needed for every soldier; now fourteen men are needed for every soldier. Yet the time lost by work accidents in 1941 was equal to the time it takes to build 9,000 large bombers or 45,000 fighter planes or 110,000 light tanks or 215 destroyers or 26 battleships.

Many of the accidents which do happen in the factories could have been avoided. There are thousands of different kinds of devices to protect the workers; some of them are built right into the machinery itself, other kinds the worker wears. But often an accident occurs because the worker was careless about using such protection or because he disobeyed the safety rules.

Each industry has its own hazards, or danger spots. The hazards in a steel mill, for instance, are different from those in a chemical plant. So the protective devices are designed according to the industry in which they are to be used, and they must be inspected regularly to see that they are working properly.

When heavy machinery is used—as in an automobile or airplane factory where large metal parts are cut out and formed by means of huge power presses—the moving parts are often enclosed in strong metal screens which are locked into place. Many of these presses are fed automatically, that is, sheets of metal are placed in position by moving belts so that the operator's hands do not need to come near the cutting part of the press. On other presses, which are fed by hand, the machine may be so designed that the cutting part can not come down until the worker's hands are out of danger. Mechanical guards are sometimes attached to the machine which automatically pull the operator's arms back, or he may use specially designed long-handled pliers for putting the metal to be cut into place.

Another form of protection on large presses is the electronic guard system. This is an electrical device which puts a "curtain" of light between the operator and the dangerous parts of the machine. If the operator's hands interfere with this curtain, the machine stops instantly.

In working with electricity, the operator must be protected against the possibility of shock. The electrical machinery itself must be made safe; generators and transmitters, which "make" and regulate electricity, are usually enclosed. Since rubber does not conduct electricity, floor mats made of rubber are used to cover concrete floors around electrical equipment.

LINEMEN WHO WORK ON HIGH ELECTRIC WIRES MUST BE PROTECTED—AND CAREFUL

You have probably seen linemen working on wires at the top of poles, along country roads. These wires may be telephone or telegraph lines, or electric light or power wires—all of them carrying currents of electricity, which are extremely dangerous on the electric light and power lines. No lineman would dare to work on these wires if he were not protected. He wears rubber gloves and shoes with spurs for climbing. Like window cleaners who work on the outside of tall buildings, he may also use a safety belt. But he knows that his safety depends on his carefulness as well.

In factories where the men handle molten metal or work in great heat, they wear clothing made of asbestos. Their shoes may have wooden soles or be made of chrome-tanned leather (leather which is specially treated for the purpose).

WORKING CLOTHES MADE OF ASBESTOS, RUBBER, LEATHER AND OTHER MATERIALS

In the chemical industries, protective clothing must be made of rubber. In general, asbestos clothing is used for protection against molten metal, heat and sparks; chrome-tanned leather against less dangerous splashes and heavy sparks; fire-proofed duck (a canvas-like fabric) against light splatters or sparks; and rubber (natural or artificial) against acids, alkalis (chemicals which would eat into most fabrics) and very hot water. Where poisonous substances are used in the manufacturing process, frequent washing of work clothes is necessary.

Eye injuries are very serious, and there are many different types of goggles for protecting the eyes. If the danger is only slight, such goggles are not very different from ordinary spectacles except that the lenses are harder. Side pieces are attached to these if there is danger from the side. Sometimes the goggles are made with a cup arrangement which completely surrounds the eye and rests against the face. A welder needs such a goggle which must also have a special lens to protect the welder's eyes from the injurious light rays given off in the welding operation. Often he wears a mask to protect his whole face from the sparks.

SOME WORKERS MUST WEAR MASKS OVER THEIR FACES

Masks made of rubber or asbestos are also used where chemicals, acids or molten metal might splash on the worker's face. In some manufacturing processes, dangerous fumes, or gases, get into the air in the workroom. Sometimes these fumes can be sucked out by an exhaust fan which draws out the impure air and lets in fresh air. In other cases the workers must wear masks to protect their breathing organs or to supply fresh air.

Where heavy objects might fall on the workers' heads, various kinds of hard hats, like the soldier's helmet, are provided. The man wears safety shoes with steel reinforced toes where heavy or sharp material might drop on his feet.

However, all the safety devices and protective clothing are only part of the picture of safety in industry. A worker who is tired is much more liable to have an accident. He may be tired because he does not stand or sit at his work properly, the shop may not get enough fresh air, he may not have room enough in which to work, or the lighting in the shop may be poor. To correct such conditions is part of the safety program in the factory.

MANY FACTORIES HAVE SMALL HOSPITALS OR FIRST-AID STATIONS

Another important point, if an accident does occur, is to see that the injured worker is promptly and properly taken care of. Many plants have small hospitals with a doctor and a nurse always there during working hours. Plants employing only a few men have first-aid stations and make arrangements with near-by physicians and hospitals to take care of emergency cases. Workers are required to get treatment for even the smallest cuts and scratches to prevent infection.

The healthier the workers, the fewer the accidents. Clean, sanitary washrooms, large enough for the number of people employed, and care in keeping the plant itself clean and orderly, also help to prevent accidents and disease. The common cold, for instance, which spreads so easily, cuts down a worker's vitality and alertness.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 6049.

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